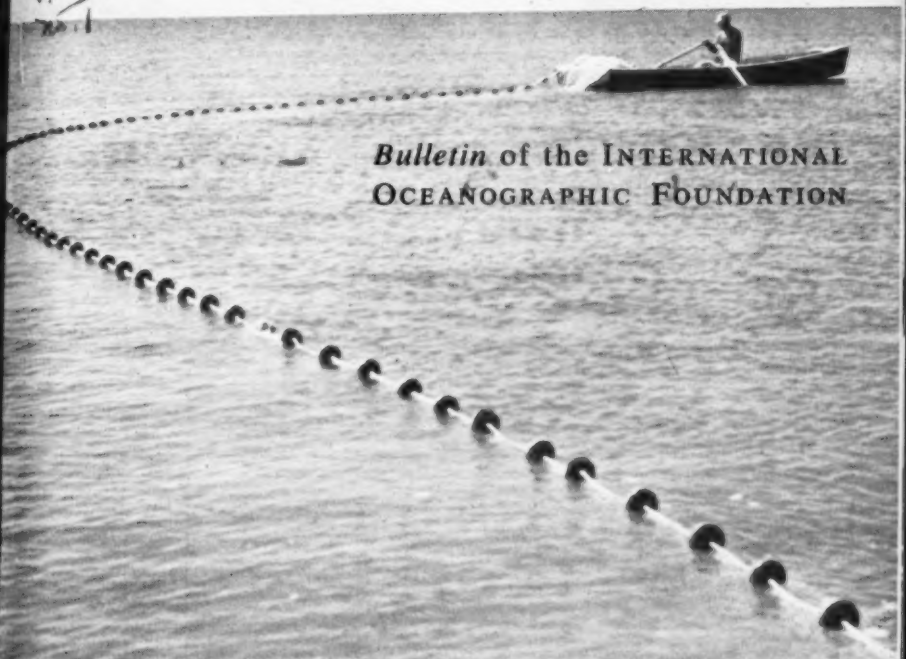
Sea Frontiers

FP
Frontiers
SD.
1
.S45
v.3
no.1



Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

March, 1957 Volume 3, No. 1

THE UNIVERSITY OF MICHIGAN LIBRARIES

THE LONGEST THING AFLOAT is not the Queen Elizabeth *(987 feet), but this Mississippi River barge tow (1,125 feet). This 15 barge semi-integrated oil tow was designed by the Dravo Corporation, Pittsburgh, for Ashland Oil and Refining Company. Combining the integration principle with complete flexibility, this 1,125 foot fleet has a capacity of 160,000 barrels. Pushing the fleet here is the 2,800 h.p., twin screw, Kort Nozzle-fitted towboat,* Tri-State.

BACK COVER: HILLSBORO INLET LIGHTHOUSE *is one of the most powerful on the East Coast of Florida. Its visibility is better than fifteen miles.*

SEA FRONTIERS

Bulletin of the INTERNATIONAL OCEANOGRAPHIC FOUNDATION

Editor: F. G. Walton Smith

Associate Editor: E. John Long

Editorial Office: The Marine Laboratory, University of Miami, Coral Gables, Fla.

Articles in this magazine are copyrighted. For permission to reprint articles, application should be made to the Editor.

Application for second class mail privilege is pending at Miami, Florida.

Table of Contents

Oceanography and Industry ..... F. G. Walton Smith 2

Royal Red Shrimp ..... Don H. Bates, Jr. 9

A British Research Vessel 14

Mystery of the Red Tide 21

The Codfish Frontier ..... Robert W. Ellis 33

Oceanography and the IGY ..... E. John Long 36

Oceanography and the Hydrographic Office 38

The Flying Fish Riddle 47

The International Game Fish Conference ..... Erl Roman 48

Science of the Sea in Books ..... Book Reviews 58

Worms with Shells 60

About the Authors 62

MODERN OFFSHORE DRILLING PLATFORMS *are towed into position. Oceanography is able to help the oil industry through numerous and varied types of research.*

Oceanography and Industry

By F. G. WALTON SMITH

TO MOST PEOPLE, even those who are interested in or associated in one way or another with the sea, the sciences of oceanography are remote and unfamiliar, except as names. Small wonder then that the value of oceanography to industry is not generally understood. Nevertheless a few farsighted industrial leaders are beginning to see the rich opportunities which are inherent in the discoveries of marine science and its applications.

Reservoir of Knowledge

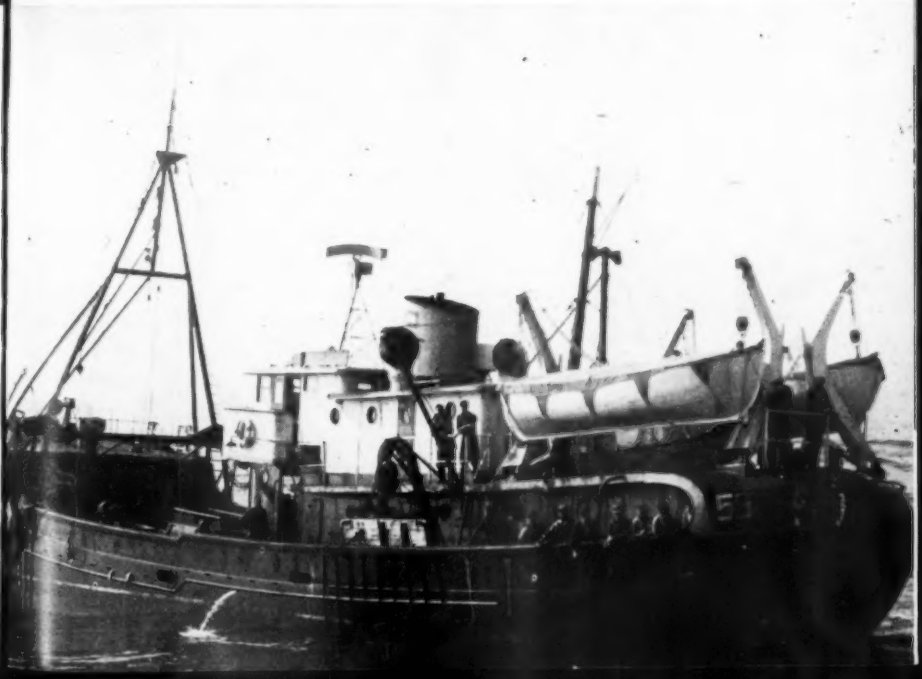
The science of the sea is relatively new. Since we live on land and use the ocean for little more than transportation, it is natural that the land has been rather thoroughly explored and scientifically investigated for hundreds of years. The ocean is more

difficult to deal with. Yet it covers more than 70% of the earth's surface. Not only does it hold great stores of valuable food and minerals but, in certain ways, it may hold the clues to some of the problems of the land and of the air, such as the origin of mountains and coasts, or the fluctuations of climate and weather. Geologists are finding that the underlying rocks of the seafloor give important clues to the whole structure of the earth. Meteorologists find the exchange of energy between air and water a vital part of the weather machine. Today we are beginning to make headway in the exploration of the ocean as a last frontier of exploration thanks to the development of new mechanical, acoustical and electronic devices which probe the deep waters like artificial extensions of our hands, our ears and our eyes. But of what value is this to industry?

The Fishing Industry

The value of oceanography to the fishing industry is fairly obvious. One major problem is that of the great fluctuations in catches which often occur, due, not only to overfishing, but also to natural causes. These may arise from comparatively simple factors acting directly upon the fish, such as the progressive warming of the seas which has in recent years extended the codfishing grounds northward. Sometimes they may be due to more indirect causes, operating upon the food of the fishes, or upon their young stages. Large

THE NEWFOUNDLAND TRAWLER Bluefoam *fishing on the Grand Banks. Oceanography aids the fisheries in many ways from improved navigation to finding new fishing grounds.*



UNDERWATER SOUND *recordings being analyzed at the Miami Marine Laboratory. This type of research aids industry through the development of navigational instruments, fish detectors, and in numerous other ways.*

scale water movements or chemical changes, for instance, may be involved. The knowledge gained by oceanographic research has been used to predict the future yield of fisheries such as the North Sea herring fishery.

Exploratory fishing for the discovery of new shrimp grounds, or for the extension of the oceanic tuna fishery may be guided by oceanographical research as a result of the understanding which it brings of the biological, chemical and physical conditions under which these creatures live. Both fisheries and engineering have gained from studies of underwater sound and the development of echometers for detecting fish. Research proceeding today may in the future lead to the practical use of electrified or illuminated nets and traps. Perhaps even new types of food may be produced from creatures or seaweeds not at present used, as a result of biochemical research.

In still another direction improved navigation methods, design of ships, long range weather prediction and the control of corrosion and shipbottom fouling are all, to varying degrees, dependent upon the investigations and discoveries of marine scientists and all in turn are of great importance to the fishing industry.

Chemicals From The Sea

The chemical industry has a stake in the future of oceanography. The oceans contain a fantastic quantity of water and dissolved in the water is a colossal amount of valuable minerals. Although there is less than a grain of gold in each ton of seawater, its oceanwide total would be sufficient to provide over 75,000 pounds of gold for every living man, woman and child on earth. It cannot today be extracted economically, but bromine, magnesium and salt have been commercially produced from the sea by the Dow Chemical Corporation among others. The basic discoveries of oceanographers may one day lead to the extraction of other chemicals. It is known that some creatures are able to concentrate many thousandfold in their tissues the tiny quantities of beryllium, vanadium and strontium dissolved in the sea. Research on how they do this might well open up techniques invaluable to industry. The importance of extracting sea minerals increases as land minerals disappear.

Scientists are seeking new chemicals and medicinal products from fish refuse. Seaweed already yields substances used in food, paper, textiles and printing industries, even in ice-cream, and may give more as research progresses, sponsored by industry and by such organizations as the Institute of Seaweed Research in Scotland. The smaller plants in the sea, the microscopically tiny cells of the plankton are present in huge quantities. Perhaps the day will come when oceanography will lead to the harvesting of this great potential food source. Marine chemists, physical oceanographers and marine biologists are continually adding basic knowledge which may one day be found of practical use in this way. Many plants and animals as yet unexploited, even the bottom sediments, may one day be brought to valuable use as marine chemists explore them further.

The Oil Industry and the Sea

Less obvious at first than the relation of marine science to the mineral industries is its relation to the petroleum industry. Yet many of the oil bearing rocks being exploited today were originally part of the ocean floor. The work of the oil geologist is aided by an increased understanding of the pattern of sediments in today's seas, which the marine biologist and geologist are actively studying. Bacteria bring about changes in the organic materials of the sea sediments and start them on their way towards becoming oil. Studies of marine bacteria at such widely separated institutions as the Scripps Institute in California and The Marine Laboratory in Miami will add to the growing understanding of how oil is formed and where it may be found. The oil geologist uses the remains of tiny marine organisms, the foraminifera, in his well borings as indications of geologic age and oil possibilities. Studies of the foraminifera living today will clarify many of his problems as oceanography goes to work. The oil industry has problems of engineering with its offshore rigs. The effect of waves and

storms must be predicted and the damage of corrosion and fouling prevented, applying the basic information provided by marine science to practical ends.

Shipping and Aviation

The shipping industry, like the fishing and petroleum industries, has problems of navigation and shipping. The study of barnacles and of the electro-chemistry of metals in sea water are basic problems to marine science but they are also the source of knowledge from which ships bottom paints and corrosion protective methods are being derived. The long range forecasting of weather for navigational purposes will increasingly gain from our present day studies at sea, as well as on the land. This will aid both aviation and surface travel. The Woods Hole Oceanographic Institute sends a special ship to sea in order to study the origin of hurricanes. The Weather Bureau sends out planes into the hurricane itself and, at The Marine Laboratory at the University of Miami, tracks the spiral bands of clouds within a hurricane by long range radar. Distant storms are predicted by changes of sea level and other measurements, made by distant marine laboratories. Even the design of ships has gained from data which originated in oceanographic studies.

Instrument Manufacture

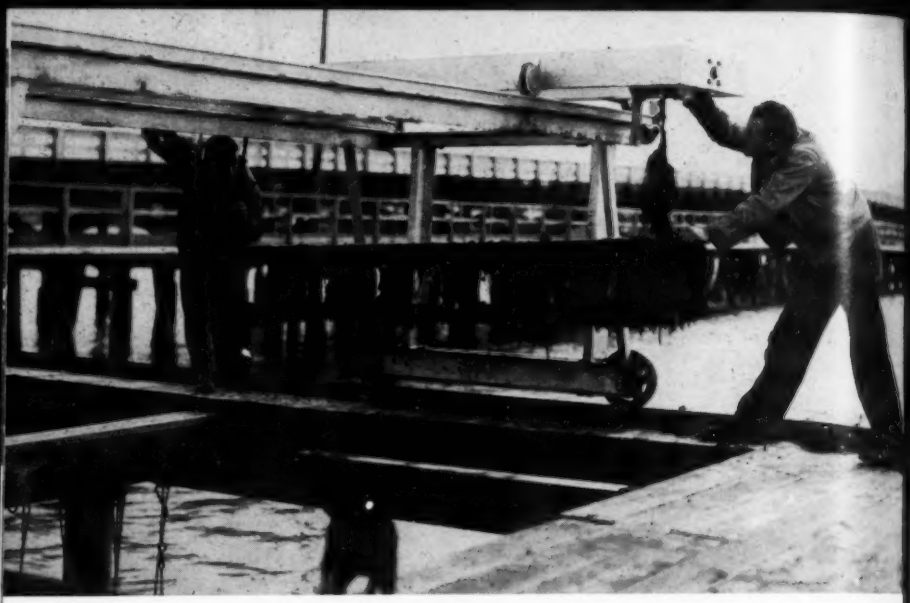
The instruments of navigation stem, in part, from the study of the propagation of sound through seawater. An extension of this has also aided in the study of the deep sea floor and seismic echo devices have given the geologist another underwater tool which indirectly helps the oil industry. Oceanographers, since they are exploring a little known field, are continually needing to develop new instruments and some of these, begun for purely scientific purposes, have found their way into industrial use or have provided important ideas for the development of industrial instruments. Deep sea exploration in particular has led the way to many of the navigational devices now used in the shipping industry.

Ideas Lead To Future Wealth

Industry, the opening up of new frontiers of wealth, depends not only upon new supplies of materials but upon a ferment of new ideas which can be applied to the exploitation of materials and energy sources. The basic scientific ideas must be continually supplied to industry from the non-commercial and university laboratories which are devoted to "basic" science, for this provides the raw materials, the building blocks, from which industry erects the wealth-producing commercial applications. Thus, to all industry concerned with the sea, whether through its minerals, its food, weather, transportation or the use of fuel oil, the sciences of oceanography are fundamentally vital.

The Foundation exists both to encourage the growth of oceanography and to acquaint industry with its advances. Through its Bulletin it aims at bringing the general public into closer contact with marine science. Through direct support of scientific

RADAR ANTENNA *used in the study of tropical storms. The work of oceanographers and meteorologists benefits all who are dependent on weather conditions.*



INSPECTION OF TEST RACKS *used for testing underwater paints at the International Nickel Company station, Wrightsville Beach, North Carolina. The deterioration of marine structures, such as ships, bridges or docks, due to corrosion, marine borers, or growth of fouling organisms, is one of the industrial problems which are being solved as the result of research in oceanographic institutions.*

research in noncommercial laboratories it hopes to aid in keeping a ferment of new ideas in the free world which will find their end result in a richer life for all. By its support of graduate training in the marine sciences it may play its part in educating the scientists of the future upon whose discoveries and ideas industry will continue to grow. Members of industry who are corporate associates of the Foundation have already begun to share in this and to pave the way to the future.

Baby Fishes One of the most interesting of current marine biological investigations is being carried out at the University of Miami, where Dr. Gilbert Voss and his assistants are examining a collection of over 20,000 baby fishes from eggs of less than one eighth inch long to young but perfectly formed fishes of an inch or so in length. Contrast these with the near half-ton adults of some of them, such as the giant bluefin tuna. This attempt to fill in some of the most glaring deficiencies of our knowledge of marine fishes is sponsored by the National Geographic Society.

A NEW DISCOVERY *in seafood. Royal Red Shrimp from about 200 fathoms. The heads amount to half the length and weight of the shrimp.*

Royal Red Shrimp

By DON H. BATES, JR.

SUCCESSFUL EXPLORATORY fishing is a combination of science, experience, perseverance, and luck. To locate and develop a new fishing ground often requires patient months or years of monotonous and thorough area coverage. Thus, it is seldom that tangible rseults are achieved in such record time as by the Fish and Wildlife Service in recent efforts off the east coast of Florida. The discovery of deep water red shrimp may well be one of the most important finds for the shrimp industry in recent years.

This particular exploratory program was conceived by a member of the Saltonstall-Kennedy advisory board, a man with a lifetime of experience in the seafood industry. He firmly believed that somewhere on the continental shelf beyond the existing South Atlantic shrimp fishery must be valuable new resources. At least the idea was worth a try, as something had to be done to supplement the steadily dwindling inshore shrimp production.

Putting an Idea to Work

With sufficient funds for at least a

THE M. V. Pelican *in Jacksonville. A standard shrimper of 70 ft. in length and a beam of 20 ft., its steel hull and stability characteristics were better than average for offshore trawling. She was rigged with an A-frame for deep water trawling as opposed to the commonly employed outrigger for standard shrimpers.*

good start on the problem, the entire implementation of the program was assigned to the Service's Gulf office at Pascagoula, Mississippi, under the leadership of Harvey Bullis, Jr., a former University of Miami graduate. The selection was a logical one. Not only had this station dealt with more than 100 species of shrimp in the Gulf in the course of several years' exploration, but it had considerable experience in the use of gear to trawl deeper waters.

To tackle intelligently the problem of a potential deep water east coast fishery, all known data about the previous explorations, bottom characteristics, and water temperatures were collected. Every marine biology station, both federal and state, from Florida to North Carolina was personally visited for information. Gradually, certain facts indicated that the real potential in the South Atlantic lay in by-passing waters between 20 and 125 fathoms and concentrating for red shrimp in deeper water if anything were to be found at all.

Right Kind of Bottom

The picture was a discouraging one. From previous explorations, most of the bottom was found to be practically devoid of shrimp life and contained little but dead shells and occasional sunken vessels to endanger the gear. No vessel in the area had ever worked beyond 125 fathoms, however, and nothing was known of this potential except that old hydrographic surveys did show areas of gray mud and favorable bottom temperatures which corresponded to known environmental conditions for red shrimp in the Gulf. This was the first encouraging sign. Closer examination of old catch records revealed

that about six shrimp (Hymenopenaeus robustus) had actually been recorded in 85 to 100 fathoms although they normally would be found in the 200 fathom area. Though not much to get excited about in itself, this information gave positive indication that the red shrimp were there. Thus, the decision to concentrate explorations in the 200 fathom area was based, of necessity, on these clues.

The Payoff

With a small field office in Jacksonville, a chartered shrimp trawler, and gear designs from the Gulf program, the first exploratory cruise was made last March. And those of us aboard that first trip will not forget the initial drag in 150 fathoms off Cape Canaveral when good quantities of these brilliant red shrimp were landed on deck.

Soon thereafter, a better concentration was found between St. Augustine and Jacksonville, the drags yielding many times the quantity of red shrimp as the inshore boats were experiencing on known stocks of white, brown, and pink shrimp. Just recently, the first commercial payload of red shrimp was landed, ending one phase of exploratory fishing that paid off in new revenue and hope for the industry.

Best of the Shrimp

The red shrimp average 26 to 30 to the pound and are, without a doubt, the most tender of all species. They possess a delicate lobster-like flavor not found in other commercial species and completely lack the somewhat objectionable iodine taste. It

OFFSHORE CATCHES *were averaging about 50% shrimp and the rest "trash" fish, including a large proportion of squid, flatfish and cod. The catch is sorted by species and weights and numbers are recorded for each.*

may be some time before they appear at your neighborhood market but a real treat awaits the consumer.

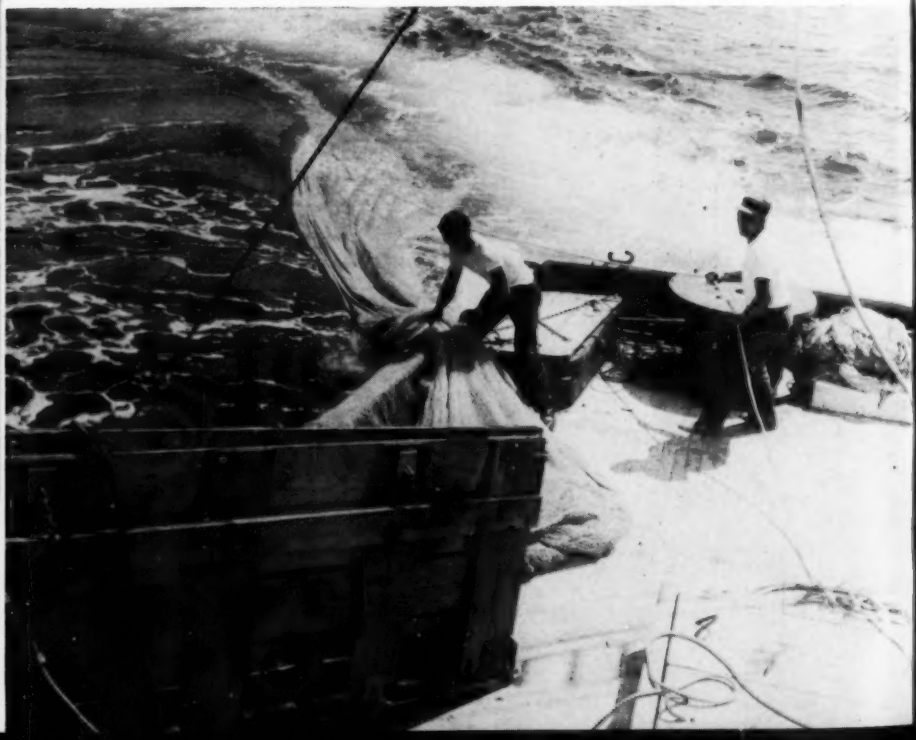
Few exploratory programs produce such rapid and spectacular results as this one. Luck played a large part in its success as, given natural conditions for the presence of a specific marine animal is certainly no guarantee that it will be there.

The Beginning, and the End

The start of commercial operations by no means marks the ending of an exploratory fishing program. Much more remains to be done. The extent of the beds must be clearly defined and seasonality determined, this being just as much a part of exploratory fishing as the initial discovery. Also, the related problem of gear development must be solved even though the program does not call for any specific work along this line. The rapid-flowing Gulf Stream and the extreme weather conditions within its confines have posed a real challenge to the explorers. Already, a good beginning has been made towards solving gear problems and if funds are sufficient, this work will continue.

Exploratory fishing pays off in other ways, not only monetarily, but in furthering the understanding and knowledge of marine life. Every drag for shrimp yields other marine life for study by interested scientists. It is an example of close harmony between the scientist and fisherman for the greatest benefit to all.

SETTING *the 80-foot balloon trawl. The net was set off the starboard quarter with the vessel circling slowly to starboard to avoid fouling the net in the screw.*



A TEN FOOT BEAM TRAWL, *especially designed for exploratory fishing. Its effectiveness at sampling the bottom exceeds nets of ordinary design. Nets such as this are of great value in the type of exploratory fishing which led to discovery of the Royal Red Shrimp beds off Cape Canaveral, Florida, and to the north.*

Tarpon To Sea Floor

The Foundation is at present supporting a number of research projects through the generosity of individual members and industrial associates.

Tarpon

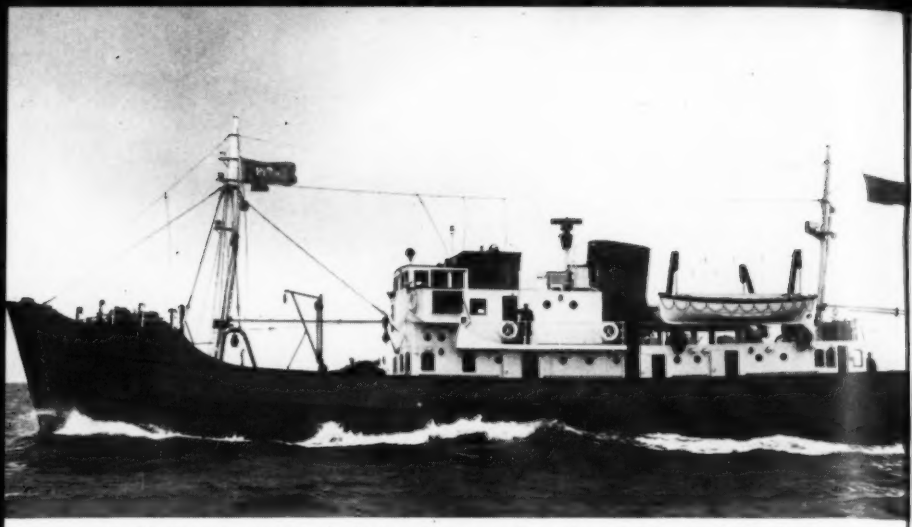
The tarpon, one of the most sporting and best fighting fishes known to anglers, is one about which surprisingly little is known. The Roger Firestone Fund, supplemented by funds from the Florida State Board of Conservation, is making possible a study of what is often called the "silver king," especially as to breeding, life history, food, growth and migration.

Ocean Fishes

The Charles F. Johnson Fund provides for a continuing investigation of the larger ocean - going or pelagic fishes, such as the marlins and tunas. A considerable body of information arising from this was reported at the Nassau Conference. (See Page 48 in this issue.)

Sediments

The Shell Oil Development Fund is making possible a graduate fellowship for the investigation of faecal pellets produced by marine animals, which may help in dating and understanding the sedimentary rocks which were once old sea floors.



R. V. SARSIA, *recently built for the research station at Plymouth, England.*

A British Research Vessel

THE PROBLEM of designing a vessel for oceanographic research may seem a simple matter except to those who are directly involved. After all, its purpose is clear. It is used to take men to sea who will bring back specimens or make measurements. Surely the equipment needed for this can be carried on a fairly small ship, since there are usually no problems of using heavy commercial fishing nets and gear or of providing space for both tons of ice and tons of fish. There is no conflict of meeting design rules and getting the highest performance such as with a racing yacht. Yet even the yacht designer rarely faces the conflicting requirements which are often met when an oceanographic research vessel starts its career on the drawing board.

Varied Types of Work

One of the sources of trouble is the varied nature of work that an oceanographic vessel may be called upon to do. The program of a marine research institute, by the very nature of scientific investigations, cannot, as a rule, be precisely determined for years in advance, since progress and discoveries will bring about changing emphasis. In the case of investigations which involve long voyages across the major oceans it may be a matter of economy to carry out as many different investigations as can be fitted to one expedition. The larger type of vessel used for such expeditions cannot be economically used for the kind of work that is carried out closer to shore, in a limited area, or on short but frequent cruises. Nevertheless, there is a natural tendency to compromise even here, as far as possible. Even the smaller vessels are often required to perform a

great variety of work, entailing various qualities of performance, a wide range of gear to be carried, from experimental fishing trawls to facilities for submarine sound study and all to be compressed into the smallest vessel consistent with seaworthy qualities, in an effort to cut operating costs.

Serious Problem Faces U.S.A.

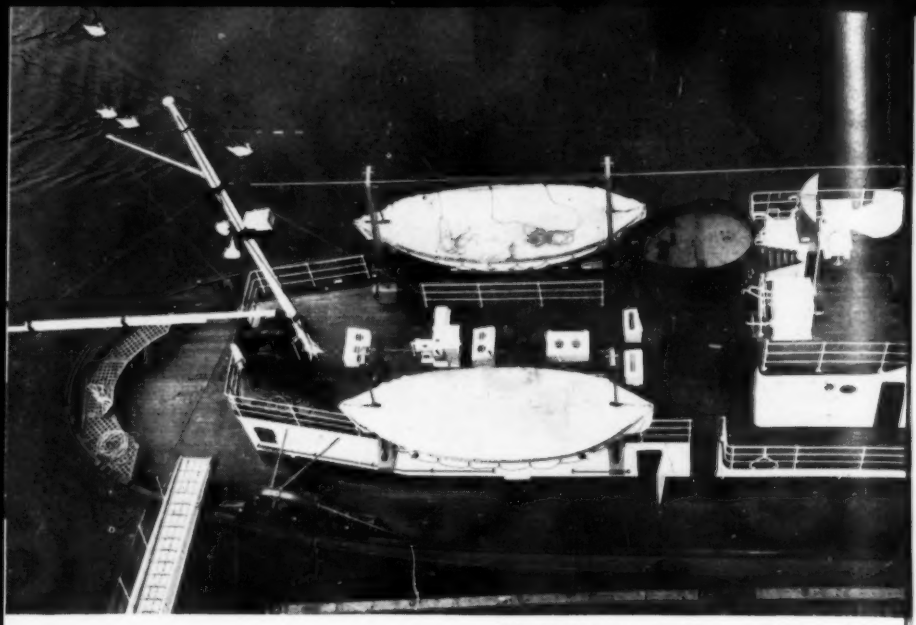
In the United States today it is no secret that most of the oceanographic vessels in use are conversions, never fully satisfactory, or else sufficiently old to be in need of early replacement. Considerable thought has therefore been given to the problems of design and it is to be expected that these problems will come increasingly to the fore in the near future. The manner in which the well known Marine Laboratory at Plymouth, England, has solved its problems of research vessel design will serve as an example of the conflicting demands which are likely to be met.

Prior to World War II the laboratory of the Marine Biological Association at Plymouth was well served by *Salpa,* a converted Lowestoft steam drifter, with an overall length of 95 feet. She was taken over by the Admiralty for naval duties and was not put back into service by the Association at the end of hostilities. The opportunity arose for designing a vessel specifically for the work of the laboratory. Fortunately this was in some ways easier for the Association than it might have been, due to the comparatively well defined scope of its work.

Biological Research

Research vessels employed in biological work involve the use of bottom dredges, nets for catching plankton and grabs for taking samples of the sea floor. Water samples may also be taken for bacteria or chemical analyses. Quite frequently marine biological studies may be closely related to the temperature and saltness of the water so that deep water sampling or hydrographic gear may be employed. Much of this gear can well be operated on small vessels of 80 feet or less in length, provided they work close to the laboratory or home port and in shallow water. If the work is related to commercial fisheries then it may be necessary to operate trawls. This may entail a larger vessel able to carry the necessary winches and gallows or A frames and this in turn increases fuel space requirements and crew quarters.

When the sea floor itself is an object of study then provision must be made for carrying core sampling devices which dig deep into the ocean floor and bring back a tubular sample of the bottom. These have been taken more than 70 feet in length below the sea floor. Obviously provision must be made for handling gear of this size. In some work the use of echoes from the sea floor and from strata well below it entail the use and transport of high explosives and electronic sound recording apparatus. A vessel which is to carry out all of these functions must be able to provide space for all of the gear used and for the scientific party to handle it.



R. V. SARSIA. *Aerial view of after deck.*

Size of Vessel Needed

The size of a vessel is also determined by the geographical range as well as the diversity of its operations. Mid-ocean work will require the ship to remain at sea longer and to carry more fuel. It will need to be larger not only for this reason but also in order to work over a wider range of sea states, to withstand greater extremes of weather and to provide more comfort for the men and scientists than if it were at sea for a few days only. For work in great depths more cable and larger winches will be required. And, of course, the larger the ship, the larger the crew and the more provision must be made for looking after the crew as well as the ship. For daily cruises on any size ship a smaller crew and scientific party may be carried than for work occupying twenty-four hours a day.

Some of the requirements for a long range mid-ocean research vessel were given in the article on *Albatross* in the March issue of the Bulletin this year and show that a vessel of 1,200 to 1,500 tons dead weight might be needed. The Russian government already has 5,000 ton oceanographic vessels in operation.

The functions of the Plymouth vessel were simpler. The ship would need to cope successfully and economically with short trips to nearby collecting grounds from which live animals could be brought back. But in contrast to this it was also expected to be able to make more extended cruises to more distant, deeper waters though not for prolonged mid-ocean work. For inshore work she must be small and handy enough for shallow water dredging and trawling. For deeper work she must be large enough to

stand up to heavy weather and provide a comfortable working platform under all reasonable conditions.

Steam Versus Diesel

The size of the vessel and her use for short daily or overnight trips ruled out steam. The cost of maintaining banked fires and steam while moored between short trips had to be considered. Yet steam is desirable for many reasons including ability to operate at very slow speeds while working gear. Nevertheless, in spite of its drawbacks, diesel propulsion was finally decided upon.

Named after Jellyfish

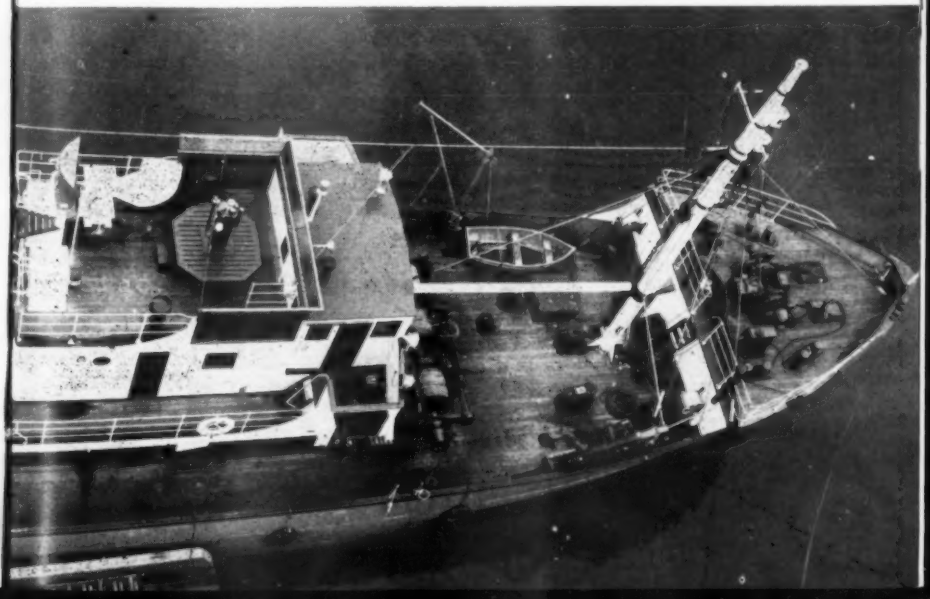
The new ship, *Sarsia,* was designed by Messrs. Graham and Woolnough of Liverpool after many conferences with the laboratory staff and was built by Messrs. Philip & Son of Dartmouth. Her name, incidentally, is taken from that of one of the jellyfish found in British waters. She is of riveted steel construction, 128 feet long by 28 feet beam and draws 9 feet 6 inches. Her designed speed is 10 knots. Her main engine is a National diesel of 290 b.h.p. which gives an economical speed of 8½ knots. The fuel capacity at this speed is sufficient to give her a steaming range of 22 days or over 4,000 miles.

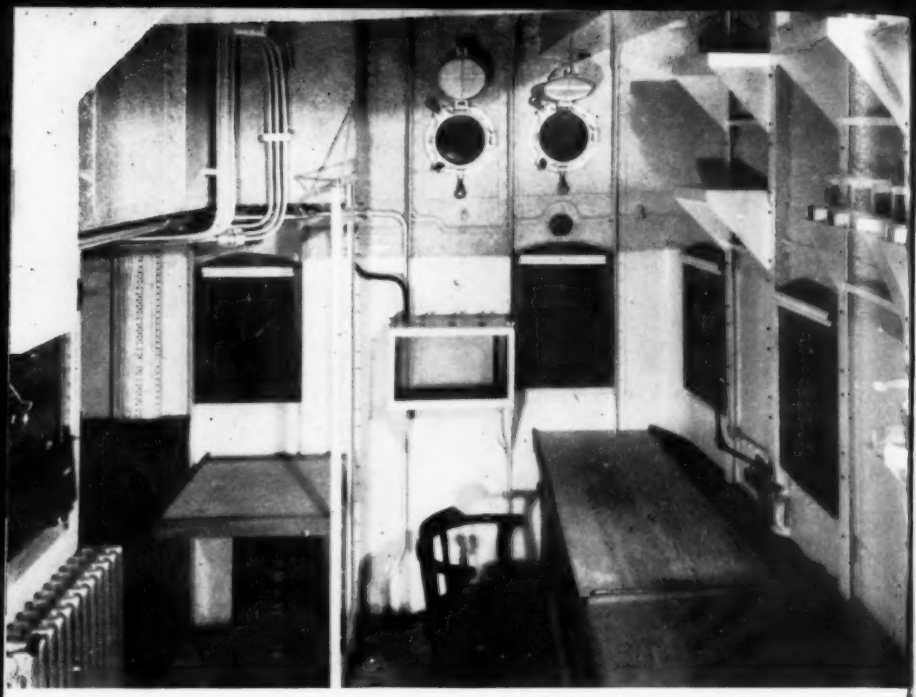
The main deck is continuous fore and aft and carries a forecastle and a large steel deckhouse, the after part of which provides a spacious boat deck. The wheelhouse, at the forward end of the deckhouse, is raised three feet above the boat deck level to provide a good forward view over the forecastle head. Within the forecastle are stored nets and dredges. The main hydrographic winch is also installed here in such a way that the operator has a clear view of the hydrographic davit through a door in the bulkhead. Its drum carries 5,000 meters of 4 mm diameter wire.

Low Speed Propulsion

The ship's machinery has been

R. V. SARSIA. *Aerial view of fore deck.*





R. V. SARSIA. *Forward laboratory looking to port. Gimbal table, right foreground. Post office racks to right.*

carefully arranged for the work. All overboard discharges from bilge and engine room are on the starboard side so as to reduce risk of contaminating water samples, which are taken over the port side forward. In order to provide for the slow speeds necessary for much of the scientific collecting and sampling operations a separate engine and low speed drive is provided independent of the main engine. A 20 horse-power variable speed electric motor is geared to the propeller shaft through the main gear box in such a way that it cannot be engaged except when the main engine is disengaged. There is ample electrical supply, including a 60 kw and a 30 kw generator. The winches are driven off the 60 kw engine by hydraulic drive.

The main 3-drum winch is placed immediately forward of the deckhouse. The port drum carries 1,800 fathoms of 1 3/8 wire, the other two, 500 fathoms of 2½ inch wire each. Wire from any drum can be led through leads to the main derrick on the foremast or to the trawl gallows on the starboard side. The hydrographic davit is fitted on the port side of the foredeck. The starboard side of the main deckhouse is kept free for trawl handling but on the port side there are fixed tanks with lids, provided with running sea water. The sea water supply pipe also provides water for portable tanks. Aft of the deckhouse is 18 feet of clear deck, providing working space when gear is

placed over the stern. On the boat deck is a second hydrographic winch with two drums holding 500 meters of 4 mm diameter wire and 300 meters of 7 mm wire.

A Note to Yachtsmen

There are two laboratories, one in the forward and the other in the after end of the deckhouse. The forward laboratory is used mainly for hydrographic work. One of the interesting features, which might well be incorporated in yacht design, is the unit system of drawers and shelves. Standard collecting bottles for water samples are placed in boxes on runners. When filled the boxes can be removed for storage elsewhere and a similar box of empty bottles replaced. Welded to the forward bulkhead are standard post office racks, which are essentially steel shelf-uprights with perforations, allowing instruments or shelves to be bolted in place as required. In this way instruments designed to fit may be set in place according to the particular requirements of each cruise. This system could probably be applied with advantage to seagoing yachts, where space is at a premium. Unit drawers with provisions for each day could be stowed away and replaced in the galley as required. Both galley and other equipment, even to clothes lockers and drawers

THE CHARTROOM *of* Sarsia, *showing the assembly of instruments used for navigation and research.*

for bosun's and other stores needed on long cruises, could be removed by unscrewing a few bolts and so giving more room for day cruising.

Provision for Electrical Instruments

Another device on *Sarsia* consists of replaceable wooden table tops fitted over the permanent, more expensive tops for the purpose of screw fittings for mounting various types of apparatus. For electrical supplies and connections between apparatus in the laboratory and elsewhere aboard the ship, there are trunks along which are led cables from the forward laboratory so as to obviate extensive use of cables along passageways and decks. Some of these terminate in watertight sockets and other cables can be passed through as required.

The after laboratory is mainly for biological work and has locker space for stowing formalin and other chemicals which must be readily available on deck. The main stores of equipment and supplies are below decks and can be drawn upon to replace the working supplies in the laboratory. A darkroom is fitted next to the after laboratory. An instrument and chart room of the wheelhouse provides ample additional space for recording instruments.

Ships Company and Quarters

The accommodations for ship's officers, crew and scientific party are adequate and comfortable. Provision is only made for a small number of scientists in one single and two double berth cabins. The crew consists of master, mate, fishing mate, three engineers, bosun, leading hand, cook and six seamen.

Sarsia has, by careful design, solved most of the conflicting needs of its particular function and has been in service during the past two years. It will easily be seen, however, that although her design fits her for the particular type of service required at Plymouth, it would not fit the special needs of every institution. Many types of work would require a larger number in the scientific party, for instance, and this might only be achieved at the expense of other facilities less urgently needed. It is clear that a one - design oceanographic vessel to suit the needs of a number of different marine laboratories would be a compromise of many conflicting requirements. Even if such vessels could be designed in, for example, three sizes, the conflicts of differences in objectives and different climatic conditions would somewhat reduce their suitability for any one of them in particular. So it seems that the one thing certain about the design of an oceanographic vessel is that it will be a compromise.

BEACHES LITTERED *with dead fish. A common sight and smell during Red Tide outbreaks.*

Mystery of The Red Tide

ONE of the commonest and yet most baffling problems of marine science underlies the red tide which has killed millions of fish off the west coast of Florida in past years. Temporarily, it caused physicians' offices to be swamped with patients suffering from the accompanying windborne irritant gas. Mounds of dead fish covered the beaches for miles and had to be bulldozed and buried in order to remove their stench. The effect on the tourist industry alone was serious enough to awaken both state and federal governments to its economic importance and eventually to set teams of scientists to work in a concentrated ef-

fort to solve the problem. What caused the sea to change color, fish to die, and visitors to develop sore throats? Marine biologists and oceanographers are following up all possible clues in an attempt to unravel the mystery and to control its devastating effects.

Many Colors

From the earliest days man has viewed with surprise and, at times, with awe the sudden appearance of a vivid discoloration in the natural waters of lakes and the sea.

Nearly always the cause turns out to be a rapid growth or "bloom" of microscopic water life, normally present in comparatively small numbers, but under certain circumstances growing and reproducing at an excessive rate until it is presently in very heavy concentrations — sufficient to affect the color, feel, taste and smell of the water and sometimes, though not always, to render it poisonous to the fish inhabiting it.

A World Wide Plague

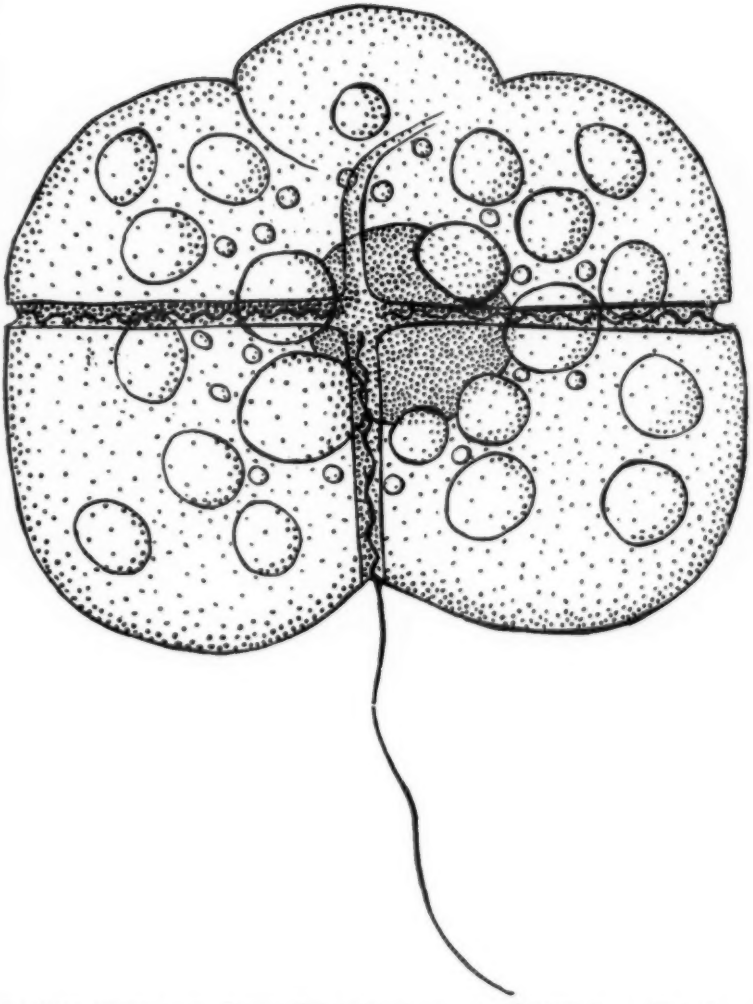
In the early fall, along the western coast of Japan, patches of water frequently become brown in color and oily in appearance, due to the blooming of one of the diatoms, a form of microscopic plant life of the sea known as *Rhizosolenia.* The abundance of another microscopic plant, the alga *Trichodesmium* is responsible for the color which gives its name to the Red Sea and to the Vermillion Sea, in the Gulf of California. Bluegreen algae in the Baltic Sea and Sea of Azov are often so numerous that the sea surface has been compared in color to a green meadow. In other places and times bacteria cause the Sicilian "Lake of Blood" and some of the shallow European seas too become discolored.

The most striking of all these plankton blooms are the red waters, known as red tides. Some were reported off the coast of Chile as far back as 1832 by Charles Darwin on the voyage of HMS *Beagle* (see Volume 1, Number 2 of this Bulletin) and from such widely scattered places as British Columbia, the Gulf of Mexico, South Africa, Japan and Australia.

Not all red tides are accompanied by the death of fishes nor are they all caused by the same organism. During the past year a red tide off the coast of Chile was investigated by an expedition of the University of Miami and found to be due to a bloom of a diatom called *Prorocentrum micans.* In other places bacteria, algae and another microscopic form of sea life, dinoflagellates, have been found responsible. In some cases jellyfish and small crustacea such as copepods and euphausids, the krill or food of whales, have caused the discoloration.

Caught by Surprise

Few people in Florida, other than fishermen, had ever heard of red tides before the latter part of 1946, when the poisonous red water began its disastrous work. Nevertheless, a careful study of past records in the library of the Miami Marine Laboratory shows that the discoloration of water and death of fish was seen off the coast of Florida as early as 1844 and on several occasions since then. But the west coast of Florida was not



THE CAUSE OF RED TIDE. Gymnodinium brevis *magnified 3,000 times. First found in the 1947 outbreak.*

then the popular area for anglers, tourists and those who wish to retire in the sun.

In November, 1946, patches of brownish water containing dead or dying fishes were seen by fishermen about 14 miles off the coast of Naples. The pestilence began to

spread northward and, during the following three or four months, it appeared at Sanibel and Captiva islands just off the coast. From Cape Romano in the south to Englewood Beach in the north dead fish were found floating in the water. Huge quantities of the dead carcasses were washed ashore, in places as much as 100 pounds to the front foot. Dr. Gordon Gunter and fellow scientists from Miami found dead turtles, shrimps, crabs and oysters as well as an impressive list of the various species of commercial and noncommercial fishes before the first series of outbreaks died down in March, 1947.

New Outbreaks and Empty Hotels

The scourge reappeared later as far north as St. Petersburg and, by the time it finally died out, in August, 1947, more fish had been killed than in the earlier outbreak.

Faced with a disastrous repetition of beaches littered with dying fish, residents and visitors complaining of irritant gases, and the hotels, motels and beach resorts changing in a few weeks from prosperous enterprises to almost deserted buildings, there was a great public outcry for action. But the inflexible system of legislature and government makes it almost impossible to authorize the moving in of a team of qualified scientists at a moment's notice or even to provide the funds for doing so.

Fortunately, however, Mr. J. N. Darling, a winter resident of Captiva Island and a well-known amateur naturalist, was present at the first outbreak. He not only made his own observations but also called the University of Miami and with his own funds helped defray the expenses of biologists who set out to investigate the problem during January, 1947.

The Counterattack Begins

The appearance of the water immediately suggested the presence of plankton bloom. By examining samples under a microscope it was soon found that a prodigious growth of microscopic organisms had indeed taken place and that one in particular seemed to be more characteristic than others. The credit for first noticing this goes, however, to Mr. Darling, whose curiosity had been aroused by strange little moving blobs of protoplasm which he noticed under a borrowed microscope. Miami scientists recognized this as a type of organism already notorious as a killer of fish when present in plankton blooms. This kind of microscopic sea life passes under the cumbersome general name of "dinoflagellates."

One of the dinoflagellates, *Gonyaulax catenella* was found to be the cause of mussel poisoning along the coast of California during the summer months. Large numbers of this organism in the plankton, when taken in as food by mussels, rendered these shellfish dangerous for human consumption. Others have been found in poison water elsewhere. One in particular bears the general name of *Gymnodinium* and it was this kind which the marine biologists found in Florida red tide. During the investigations as many as 60,000,000 individual cells to the pint of water were found in the affected waters.

Meet "Jim Brevis"

Examination of the *Gymnodinium* present in the Florida outbreaks showed that it is a four-lobed blob of almost naked protoplasm, with a whip-like flagellum trailing from one end. Although practically transparent, the organism carries oval shaped objects which give it color. It secretes a slimy substance from its surface in huge concentrations and this in turn gives the water the consistency of thin syrup.

The first step was to determine exactly which species of *Gymnodinium* was causing the damage. Careful study disclosed it to be different from any previously known to science. Accordingly, Dr. Charles Davis, of the Miami staff, wrote a careful description and officially named it a new species, *Gymnodinium brevis*. It was not long before the press and the general public nicknamed it "Jim Brevis." It is still known by this to the residents of Florida's west coast.

Gas Warfare or Foreign Agents?

While this was happening there were many other theories advanced, both by the general public and by armchair scientists. Some said that non-poisonous plankton clogged the gills of fishes and asphyxiated them. Others held that wartime poison gases had been dumped into the ocean and that the release of these was responsible both for dead fish and the sore throats, quite forgetting that red tide, dead fish and sore throats had appeared off the Florida coast long before any war gas was available for dumping. Some theories were even more fantastic, involving the deadly and secret activities of foreign agents.

THE BATHYTHERMOGRAPH. *An instrument used for measuring the temperature of sea water at different depths. Temperature measurements are essential in studying the water movements which favor Red Tide outbreaks.*

But the investigators by now were satisfied as to the immediate cause of the trouble. Small fishes were placed in samples of water containing Jim Brevis. The fishes died in less than 24 hours. In similar tanks of water with no Jim Brevis the fishes lived. Samples of seawater from a red tide outbreak were heated nearly to boiling point and the vapor given off was found to cause coughing and sneezing.

Unfavorable publicity in the wake of the red tide troubles led to a vigorous effort to combat them and the scientists from Miami who conducted the original investigation were now reinforced by investigators from the

U.S. Fish and Wildlife Service and the Woods Hole Oceanographic Institute. Dr. Paul S. Galtsoff confirmed the original findings of the poisonous nature of Jim Brevis by carefully conducted tests. Irritant gas, first earlier obtained by boiling red tide water, was traced by Alfred Woodcock to small particles of water thrown into the air by breaking waves, and remaining in suspension for a considerable time. In this way the red tide poison became airborne. Injection of a small amount of red tide water by spray into the nose caused the familiar sneezing and sore throat, thus confirming Woodcock's theory.

The Cause of a Cause

The direct cause of red tide and its attendant evils was clear enough. The recognition of Jim Brevis did not help very greatly in preventing it though. It is true that copper sulfate and other chemicals have long been known as potential killers of plankton blooms if sprayed on the sea, but, by the time a red tide outbreak is noticed, the fishes are dead and drifting onto the beaches and the tourists and residents are coughing and sneezing. It is then too late. Like an explosion, the red tide must be stopped before it breaks out. It is necessary to predict the time and place of an outbreak. The $64 question was, what are the events or causes which *antedate* the sudden catastrophic blooming of "Jim Brevis?"

An obvious thing to look for is the source of food to support the rapid growth of plankton characteristic of plankton blooms. In Florida there seemed to be a ready answer in the existence of phosphate mining operations. Land plants need fertilizer—phosphorus, nitrogen, potassium—for food and also certain other substances in very small quantities to promote and sustain growth. This is equally true even of small plant-like cells in the sea, including "Jim Brevis." Moreover it frequently happens that the phosphorus compounds are the least plentiful, so that any sudden increase in their quantity in the sea may lead to a great growth of plankton.

Rainfall and Red Tide

The Miami scientists, together with others from the University of Florida and the U.S. Fish and Wildlife Service followed up these speculations. The probability in mind was that excessive rainfall or an equivalent type of mechanism might wash down into the sea unusual quantities of phosphorus dissolved out of the phosphate rocks inland, or from the mining refuse by way of rivers. Unfortunately the final analysis seemed to show that even in years of no red tide there is sufficient phosphorus in west coast Florida waters to support a red tide outbreak. Why then is red tide not *always* present? A possible clue comes from a study of rainfall and river discharge. There seemed to be some connection between red tide outbreaks and a higher than average river discharge. But red tide had not developed in all of the past years when rainfall or river discharge was high. So something else must be involved.

There were indications that in the shallow creeks and bays, sepa-

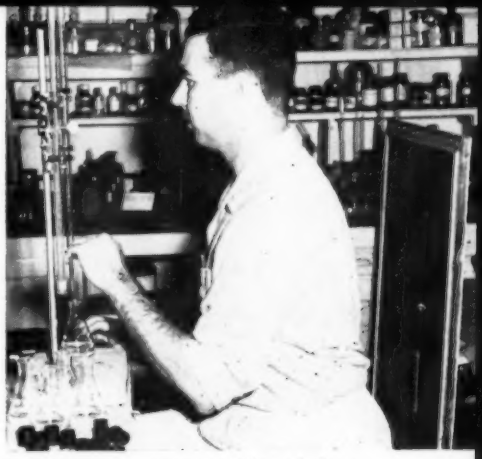
rated from Gulf of Mexico waters by a chain of islands, materials important to the growth of "Jim Brevis" occurred and that the mixture of this water with the seawater outside might provide exactly the right conditions for red tide development.

Research Almost Abandoned

Careful detective work was almost brought to a stop at this stage. Since 1947 red tide seemed to have disappeared and there was no way of telling whether it might return in one year or ten years. Consequently public interest disappeared and with it also the funds necessary to continue research. The problem now facing the scientist was not red tide, but the difficulty of being able to continue investigations without interruption. It is unhappily true that legislatures and governments, being in the public service and sensitive to public opinion, are apt to finance research only when an emergency such as the red tide actually occurs, at which time, paradoxically, the necessary delays in legislative machinery render it too late to be of service. As soon as the emergency is over, all of the painstaking ground work which could lead to the final answer is likely to be discarded.

New Outbreaks Reopen Research

Although marine biologists from Miami were unable to follow up their earlier discoveries in full measure and although the Fish and Wildlife Service Laboratory at Sarasota was closed, scientific interest continued since it was to be expected that at some undetermined future time the plague of dead fish would return and with it a public clamor for a solution.



SEA WATER ANALYSIS *at Miami helps unravel the Red Tide mystery.*

These expectations were partly realized in 1952 when a fresh but minor outbreak occurred. About the middle of September, 1953 further red tide was reported and this continued at intervals throughout the winter and in the spring and summer of 1954. The new alarms brought special funds to aid research at Miami and increased federal activity. The State of Florida made a wise move by setting up a Red Tide Committee in order to coordinate research activities. This might also serve to keep legislature advised of the need for continuing research between red tide years.

Red Tide in Test Tubes

Materials are needed for the growth of "Jim Brevis" and the suspicion that the brackish bay waters contained some essential part of these materials received new attention as the result of work carried out by the Haskins Laboratory in New York. For the first time the red tide type of organism was kept alive in the lab-

CALCULATIONS *of water movement are based on records from the bathythermograph which are being examined here.*

oratory in a pure culture, uncontaminated by bacteria or other organisms. The Fish and Wildlife Service followed this up and is now seeking more detailed information about the food requirements and behavior of Jim Brevis in the laboratory.

Part of this is being done at Galveston, Texas, part in Florida in a laboratory in Naples where a converted cabin cruiser is stationed. Many of the questions of the likes and dislikes of "Jim Brevis" may thus be answered by the Service, which now has a team of 20 people engaged in the investigation. Not only is "Jim Brevis" being kept alive for studies of his daily needs, but experiments are being conducted to determine the best way of killing him.

Predictions and Patterns

As the Fish and Wildlife Service attacks one side of the problem, a four-man team from Miami advanced from another direction. In order to kill "Jim Brevis" and to prevent the red tide spreading, even if a suitable poison were available, it would still be necessary to know in advance when and where an outbreak was likely to take place and how it was likely to spread.

Red tide first appears as a patch of discolored water, with dead and dying fishes, particularly along its edge. Within a few days the enormous concentration of microscopic dinoflagellates brings about their own death by overcrowding, the red color vanishes, and after the dead fish have been drifted ashore, all the typical signs begin to disappear. Several days

or even weeks later, however, a similar outbreak may take place at another part of the coast. In a typical red tide year succession of such outbreaks at different parts of the coast may occur with varying intervals of time.

What was the connection between successive outbreaks? In order to prevent the death of fish by poisoning "Jim Brevis" before it could bloom, it now seemed clear that not only must the first outbreak be predicted but it must also be possible to predict the pattern of future successive outbreaks. These were the tasks undertaken by the Miami oceanographers.

A New Line of Attack

First, records of all past outbreaks were examined in great detail. They suggested that when one or perhaps several patches of water become suitable for a red tide outbreak they might be carried by the system of water currents to other parts of the coast. This new way of attacking the problem has finally given a clue to the prediction of red tides.

The fully equipped seagoing research vessel, *Gerda*, (see article in Volume 2, Number 2 of this Bulletin) with all of the latest types of apparatus for studying conditions at sea left Miami for the west coast of Florida. Under the direction of oceanographers Ilmo Hela and Frank Chew, there began a long and exacting study of the water currents and tides in every detail. (See "Rivers in the Sea", Page 89, Volume 2, No. 2). By working night and day while out at sea they accumulated a prodigious amount of data. Back at the laboratory, samples of sea water were examined chemically and the long task of mathematical analysis began.

A Scientific Fleet

Results were checked and analyzed by the use of free drifting buoys and floating cards, whose travel between the time of dropping in the water and the time and place where found gave further evidence of water movement. On occasions a large fleet of yachtsmen, fishermen and power squadron members cooperated by dropping cards, identified by numbers, in the waters at numerous places simultaneously. Several days later they returned to locate the cards, floating in their sealed plastic covers.

The complicated pattern of currents changes somewhat with the season of the year, so that it was necessary to repeat the work at sea on a number of occasions. But the interlocking system of currents that gradually unfolded showed how red tide could, apparently haphazardly, jump from place to place, as the affected water was carried along. This led to the next stage in the attempt to predict red tides.

What Makes Water Mix

Water flowing in tides and currents and acted upon by wind and wave tends to mix and this would tend to disperse red tide water. If a water mass was to remain red tide active while moving along the coast it must not mix too quickly with surrounding harmless water and so be dissipated. Therefore, said the oceanographers as they reviewed the results of the *Gerda* cruises, we must next find out just what the conditions are that

A CURRENT METER *being lowered from a Miami research vessel. Currents play an important part in Red Tide outbreaks.*

prevent mixing. These will be the conditions which allow a series of red tide outbreaks to occur and they may well lead us to a method of prediction.

Chew and his group from Miami worked out a mathematical formula. In simple language it said that "sea water becomes heavier or denser as it becomes cooler or more salt, but less dense as it warms up or becomes fresher. The mixed bay and Gulf water which supports red tides is lighter than Gulf of Mexico seawater. The red tide water therefore tends to float above the rest. If it is very much lighter, though, it spreads out like an oil film and so begins to disappear. If it is only slightly lighter than the Gulf water it will mix more easily." So, for red tide to progress into a major series of outbreaks the difference in density must be neither too much nor too little.

But how could this density be predicted? Clearly it was related to the amount of brackish water entering

the ocean and so to the freshwater entering the bays and this in turn to river drainage and rainfall during the previous months. It was also related to the difference in temperature between Gulf water and bay water and consequently to the air temperature of winds which influence them.

Success

It seemed a long shot, but after taking meteorological figures for twenty-six past years and performing numerous calculations with different combinations of the data, a formula emerged which worked. The weather information for any year was placed into the formula. When the numerical result fell within a certain narrow range, then a red tide outbreak happened during the next twelve months. If outside the range, there was no red tide.

But this was only a start. The test would come when predictions for future years could be checked. Time was of the essence, since a red tide outbreak is a serious matter to the west coast residents, and might well cause millions of dollars of lost business if not controlled. So, though a scientist does not like to take chances, it was decided, even before the theory had been fully worked out, to risk a forecast. In November of 1955 the State Board of Conservation in Florida was notified that there was little likelihood of major red tide outbreaks in the year 1956. It turned out there was none. A similar prediction was made for 1957. The west coast waters of Florida will be watched with interest to see if it holds good.

What of the Future?

There have been no serious outbreaks since 1954. If history were repeated, then public interest would die and research would be dropped. But this time there is a committee watchful of the citizens' interests to guard the future. The U.S. Fish and Wildlife Service may continue to probe the needs of "Jim Brevis" and the cooperating group from Miami may be able to extend its method of prediction so as to forecast the time and place of the next outbreak and so as to stop it before it starts.

Already there are indications that a knowledge of tidal movements will play a part in this. Information from the Miami field station at Boca Grande and from the hard working research ship *Gerda,* combined with the facts growing from the Fish and Wildlife Service studies, may in the not too distant future bring about a sure control of the plague of Florida's west coast, the red tide.

PORTUGUESE DORY FISHING SCHOONERS *at St. Johns, Newfoundland, picking up bait and stores before returning to the Grand Bank fishing grounds. The Banks is a meeting place for fishermen from many distant countries.*

The Codfish Frontier

By ROBERT W. ELLIS
The Marine Laboratory, University of Miami

NEWFOUNDLAND, it is said, is "the island surrounded by cod." There is some truth in this description. Certainly the waters around this little known island, formerly Britain's oldest colony, are prolific with this cold water fish. For several centuries, fishermen from many countries of the world have shared in Newfoundland's abundant cod harvest. Here is a fishing area that is truly international, in which the marine scientists of a number of countries have a strong professional interest.

The island itself sits in the mouth of the Gulf of St. Lawrence. Its 6,000 miles of rugged coast, along with Labrador on the mainland, make up one of Canada's maritime provinces. To the east, it juts far into the Atlantic. In fact, Cape Spear, just south of the capital, St. Johns, is the most easterly point of the North American continent. A feature of great importance to the island's fishing economy is the strong flow of the Labrador Current which washes the east and west coasts of the island on its track from the Arctic to New England.

Frigid but Fertile

This cold water stream, often carrying with it large icebergs, has a marked effect on the climate. Winters over much of the island are hard and life not too comfortable. On the other hand, this current also plays its part in creating water conditions which are favorable to the growth of plant life in the sea, and so, indirectly, to the growth of cod and other cold water fishes. Cod eat squid, capelin, herring and other smaller sea creatures. These, in turn, eat smaller plants and animals and so on until we reach the microscopic plant life or plankton. The Labrador Current is rich in dissolved fertilizer. A chain reaction starting from this causes abundant plankton, thus, plankton feeders, and ultimately more codfish. The reasons that these waters are perhaps the most productive in the world are much more complex than this, however. It remains for science to work out the pattern in detail.

A feature which Newfoundland fisheries share with those of other arctic and subarctic areas is the comparatively small number of species making up the commercial catch. The bulk of Newfoundland's catch is composed of cod, haddock, American plaice, redfish and halibut. Only a few others are marketed. In tropical waters, on the other hand, approximately seventy different species are sold commercially.

The Scientists' Role

An area so productive is clearly of great interest to fishery scientists and oceanographers. Research work has been underway for many years by the Newfoundland Fisheries Research

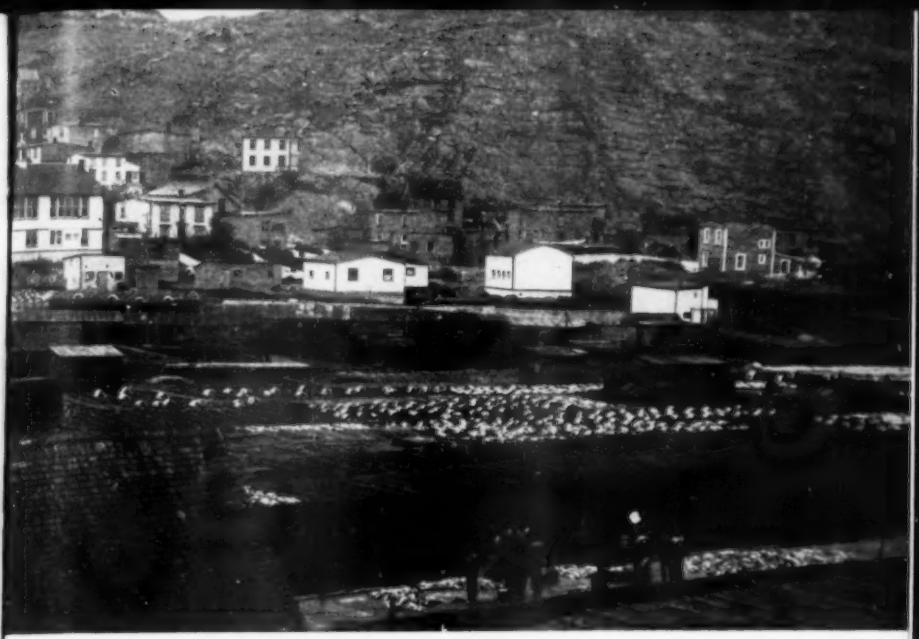
ABOARD A NEWFOUNDLAND *diesel trawler. The cod end of a trawler, filled with fish is hoisted over the side of a vessel. The end will be opened by untying a rope knot and the fish let out on to the deck.*

Station (formerly the Newfoundland Biological Station) and some valuable results already have been achieved. One important discovery is that the distribution of several kinds of commercial fish in the area appears to be related to the temperature at the bottom of the sea. This method of "fishing by thermometer" has had some success and is particularly useful for locating new fishing grounds. The work done in this area has also revealed much of the life histories of the major commercial species by sampling and tagging. Valuable work has also been done in the search for new fishing grounds and for new methods of fishing.

Scientists from other countries whose nationals participate in the fishery also have made studies in the area. In 1951, the administration of all marine research work between Greenland and New England (including Newfoundland) became the responsibility of the newly formed International Commission for Northwest Atlantic Fisheries (I.C.N.A.F.) This organization, composed of scientists, legislators and trade representatives from ten countries, was formed to coordinate research work and to consider methods of regulating the fisheries. In the short period of its existence, a great deal of useful work has resulted from the Commission activities in an area where both fishing and research are conducted under very rigorous conditions of unfavorable weather and freezing temperatures. Mariners who have passed through this area will be familiar with the fog conditions which persist for many months around the coasts of Newfoundland and on the fishing banks and which provides a serious hazard to navigation.

Even the Arctic is Warming Up

In recent years there have been signs that the climate of Newfoundland is becoming warmer. The Newfoundlanders, wading through slush and heavy winter rain, talk nostalgically of the old days when snow drifts of twenty feet or more were common. Dr. Wilfred Templeman, Director of the Newfoundland Fisheries Research Station, discussed the effects of this warming up on the



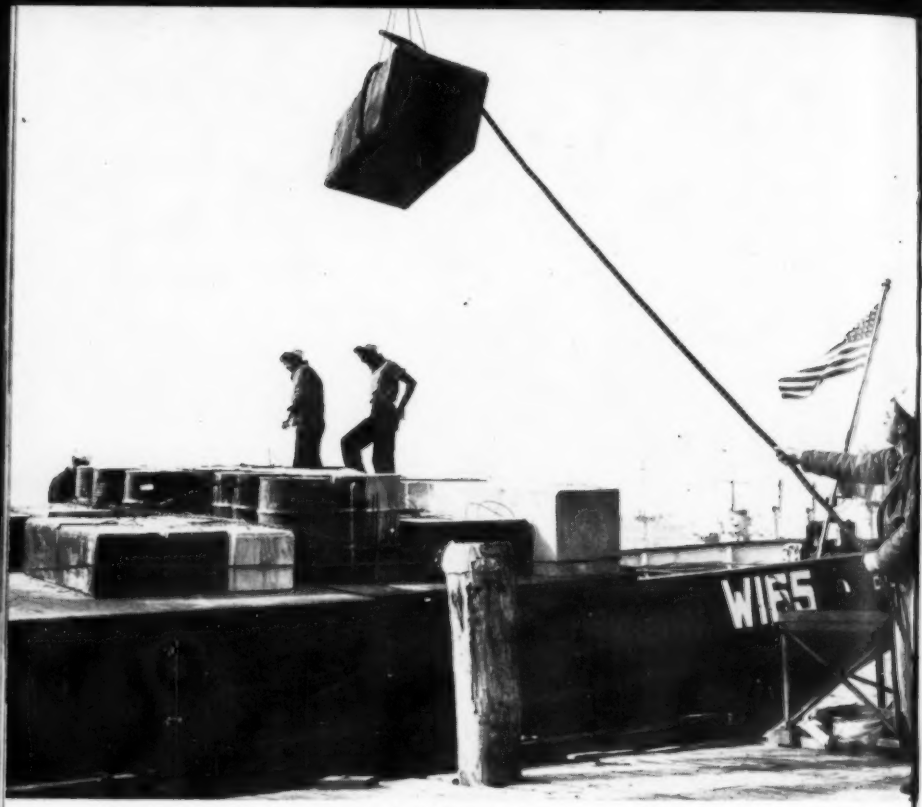
CODFISH *in process of treatment at a Newfoundland "outport" or fishing village. The fish, after splitting and salting, are laid out in the sun to dry on wooden stages or "flakes."*

abundance of marine animals a few years ago at an I.C.N.A.F. meeting. One important change has been in the extension of the cod frontier further north. The effects of this climatic change on the fishing economy have been mixed. For example, mackerel are much more abundant around the Newfoundland coasts than formerly, while the capelin appears to have been driven further north, away from Newfoundland, once the southern fringe of its range.

What of the Future?

The exploitation of the fisheries around Newfoundland becomes more intensive every year. Every fishing season brings larger and more modern trawlers into the area from the protein hungry countries of Europe, whose own fishing grounds are becoming depleted. Until recently much of the fishing was done by hand lining from open dories, a method which does not damage the young fish, on which the stocks of the future depend. The importance of this type of fishing is decreasing in favor of trawlers dragging heavy trawls over the sea bottom. This method shows very little distinction in catching large or small fish.

Scientists are studying these and other problems very actively. Mesh regulations are being considered which, when implemented, will enable the small, unmarketable fish to escape and form the stocks of tomorrow. With wise laws such as these, Newfoundland waters should continue to yield large catches to the fishermen of the world.



LOADING CEMENT VAULTS *and oil drums containing radio-active wastes from the National Institutes of Health, Bethesda, Md. From the Coast Guard station at Norfolk the lethal load is towed far out to sea, and the vaults and drums are consigned to the deeps. IGY studies may determinine whether this is a safe procedure.*

Oceanography And The IGY

By E. JOHN LONG

THE initials I.G.Y. have already become so familiar that it seems hardly necessary to explain that they stand for "International Geophysical Year," the world-wide scientific undertaking that will open officially on July 1, 1957, and extend through December 31, 1958.

Plans for the project, which include the participation of fifty-six nations, are now complete. Equipment and supplies have been moved into many normally inaccessible areas, such as isolated islands, equatorial jungles, and the snowy wastes of the Arctic and Antarctic. Arrangements are also being made for the launching and camera-tracking of an earth satellite.

A total of eleven scientific fields will be studied on a broader geographic basis than has previously been possible. One of the eleven is "Oceanography."

Some of the Aims

In a speech before the Scientific Research Society of America, in Philadelphia, Pa., January 28, 1957, Dr. J. Wallace Joyce, Head of the National Science Foundation's Office for the IGY, gave a few of the objectives in each of the eleven fields.

Here is what he said about "Oceanography":

"Oceanography is another geophysical discipline that is of vital interest and importance to the world's population. The vast sea areas that cover three-quarters of the earth's surface profoundly affect the world's weather. In addition, the seas have always been a prime source of food, a role that may well increase in importance as populations continue to grow.

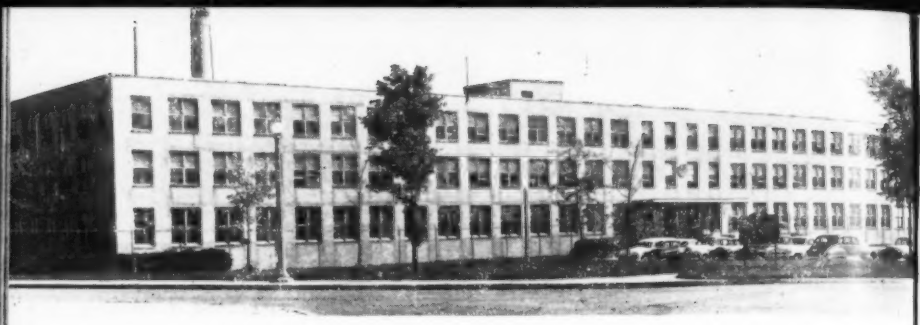
"Surface currents of the oceans have been mapped and studied for many years. We know of their general features, but we need more data concerning their courses and their periodic variations, both long and short time, if we are to obtain a better understanding of the role they play in the weather. This understanding is needed particularly in the field of long-range weather forecasting.

Deep Currents

"Of the deep currents that exist in the ocean, practically nothing is known. They are probably related to large movements of water masses, and they certainly provide an important mechanism for the "turning over" of the oceans, a vital factor with respect to the total life that can exist in the sea.

"In addition to the importance of these deep currents, therefore, in terms of both weather and food, there is a third possible area for their utilization. This is in the disposal of radioactive wastes that will result from wider uses of nuclear power for peaceful purposes. The ocean deeps are ideal dumping grounds for such material if we can be certain that the waters thus exposed to contamination will not be brought up to shallower depths until these wastes have become harmless.

"At present we do not know whether the deep waters come to the surface in a matter of tens or of hundreds of years. Once some idea is obtained of this rate of flow, and provided the answer is favorable, we may have a practical solution to the radioactive-waste problem."



Oceanography And The Hydrographic Office

TWO SHIPS ARE riding at anchor in a certain harbor. Suddenly, they collide. Which one dragged its anchor and failed to keep a proper watch?...An important piece of naval equipment is to be tested in order to observe its performance in rough seas. Where and when may rough seas be expected off the east coast of the United States within the next 30 days?... The weather and radar stations along the northern edge of the North American Continent on the Arctic Ocean are in urgent need of supplies and heavy equipment that cannot be brought in by plane. What is the best time to send ships into these ice-infested waters to resupply these bases and still get the ships out safely?

These are some of the numerous questions frequently asked of the Hydrographic Office by various Government agencies and private parties. In order to be able to furnish reasonable answers, this Office must have on hand a large store of oceanographic data on currents, sea and swell, and sea ice from which suitable explanations and forecasts can be made. In addition, large quantities of all types of oceanographic data are required in order to supply military planners with marine environmental studies for various purposes.

In order that this bank of information be continually enlarged and the Hydrographic Office fulfill more effectively its responsibility as the central repository of oceanographic data in the United States, full advantage must be taken of every opportunity to collect such data from all ships, both within the Navy and without.

Beginnings

This preoccupation with acquiring vital information from the sea is not new. Since its founding in 1830, the Hydrographic Office of the U. S. Navy has, during most of its existence, been intimately associated with the scientific study of the ocean. The father of American oceanography, Matthew Fontaine Maury, served as officer in charge of the Depot of Charts and Instruments (as it was then called) from 1842 to 1861. Although not a trained scientist, Lieutenant Maury capably directed the scientific compilation of logbook data on winds, currents, barometric pressure, soundings, and the distribution of whales. The resulting graphic pres-

entations, which were described and annotated in a series of Sailing Directions, formed the basis of the present Pilot Charts, still issued by the Hydrographic Office.

These Sailing Directions, incidentally, which grew with each edition until in 1858 they comprised two volumes totaling 1,290 pages, are filled with first-hand accounts of the sailing performance of clipper ships making gold-rush voyages to California and tea runs home from China. As unique source material on the sailing qualities of the ships of that period, and the ocean routes which they traveled, they have become collectors' items today.

Other information not suited for immediate application by shipmasters was compiled by Maury into a comprehensive volume "The Physical Geography of the Sea," which was published by Harpers in 1855 and had an instantaneous success as a nonfiction best seller. Revised and enlarged several times by 1860, and translated into six languages, the "Physical Geography" was cited as a standard work on oceanography for over twenty years after its first appearance.

Hydrographic Office Established

Promoted to commander in 1858, Maury resigned in 1861 to share the fortunes of his native state of Virginia, and the work that he had initiated was abandoned during the Civil War. In 1866 an act of Congress provided that "there shall be a Hydrographic Office attached to the Bureau of Navigation in the Navy Department, for the improvement of the means for navigating safely the vessels of the Navy and of the mercantile marine, by providing, under the authority of the Secretary of the Navy, accurate and cheap nautical charts, sailing directions, navigators, and manuals of instructions, for the use of all vessels of the United States, and for the benefit and use of navigators generally."

Until this act was passed, the office combined the functions of both the present Naval Observatory and the Hydrographic Office. Maury, in fact, had usually referred to his post as the "National Observatory." Under the new legislation the hydrographic functions were separated from the astronomical functions, and the Hydrographic Office was formally commissioned on August 1, 1866.

The collection of marine meteorological and oceanographic information from ships was begun again in 1873, and the resulting data formed the basis for a series of Pilot Charts of the oceans, the first of which appeared in 1883. An interesting aspect of the work during this period was the experimental use of Hollerith punch cards (invented in 1887 by the then Director of the Census) for tabulating marine meteorological data, beginning in 1894. Evidently hand-tabulation methods proved adequate for a number of years, for the system was not finally adopted until 1932.

Meanwhile, a succession of executive orders, laws, and agreements clarified the division of responsibility for marine meteorology between the Navy and the Weather Bureau, and in 1913 it was arranged that the Weather Bureau would furnish the meteorological data for Pilot Charts.

THE U.S.S. San Pablo *(AGS-30) and U.S.S.* Rehoboth *(AGS-50) at a recent visit to Monte Carlo.*

Present Activities

The oceanographic activities of the Hydrographic Office now are so far flung and diversified as to make it almost impossible to give an account of each. Although ships are specifically assigned to this Office for surveying work, efforts are continually being made to enlist the cooperation of many ships belonging to other Navy activities, the Coast Guard, Fish and Wildlife Service, Coast and Geodetic Survey, as well as the private oceanographic institutions.

Of the ships assigned to the Hydrographic Office, the *U.S.S. San Pablo* and *U.S.S. Rehoboth,* two of the largest survey vessels in the world, have steamed over 350,000 nautical miles since 1948 and have occupied over 1,500 oceanographic stations, sometimes anchoring in water as deep as 2,400 fathoms. A smaller vessel, the YF-854, does similar work closer to port, and has covered areas as far apart as Panama and Alaska. These ships at present are engaged in a series of special projects which will take them into the North and South Atlantic and off the west coast of the United States.

The bulk of our surveying activity, however, is performed in cooperation with long-range programs of other agencies. The most important of these will be described briefly.

International Geophysical Year

In connection with the oceanographic program for the International Geophysical Year (IGY), the Hydrographic Office has already participated in two cruises to Antarctica and is getting ready for a third.

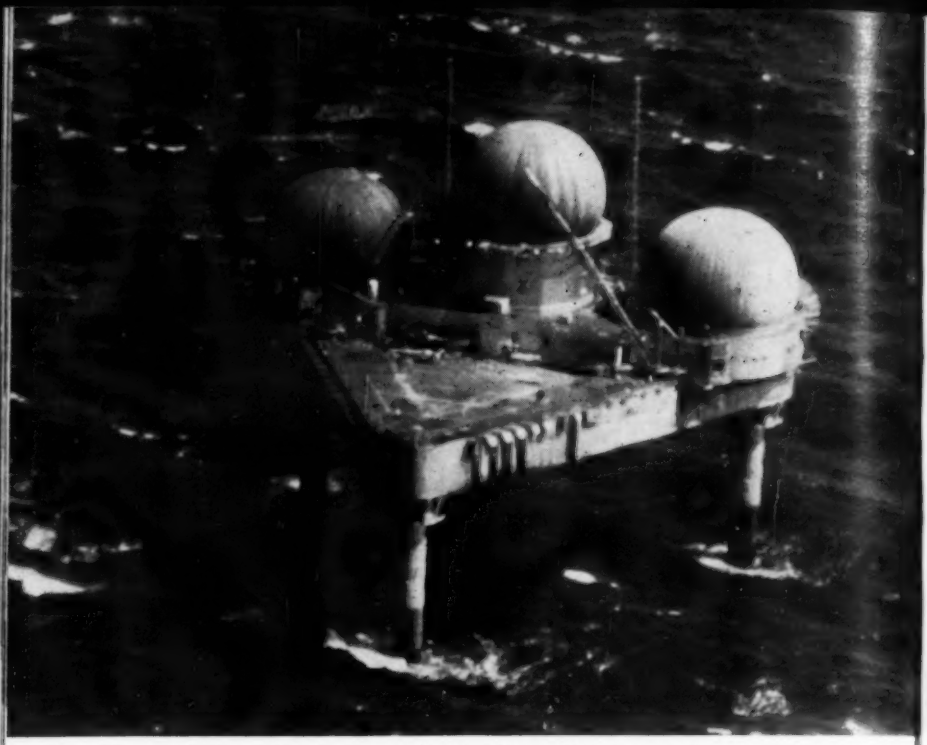
The first Antarctic Expedition, 1954-1955, was a reconnaissance survey of the Ross and Weddell Sea areas to select sites for future bases during the IGY program. Secondary projects consisted of scientific investigations, largely in the geophysical sciences. Oceanographic investigations were carried out on a not-to-interfere basis, or whenever it was possible to stop the ship for periods of two hours or more. Bottom sediment cores were obtained when it was possible to stop the ship for half-hour periods, ice conditions permitting. Stations were taken in the Atlantic on the way to Antarctica, and in the Pacific and through the Panama Canal on the return trip.

Deep Freeze

The second Antarctic Expedition, 1955-1956, known as *Deepfreeze I*, was for the purpose of establishing bases in Little America V and McMurdo Air Operation Facility; also to reconnoiter Knox Coast and Cape Adare for additional base sites. Most of the oceanography on this cruise was done in the Ross Sea area with a few stations at other Antarctic coastal points and off Chile.

Deepfreeze II, 1956-1957, will transport scientific personnel to previously established bases, resupply those bases, and establish additional bases in the Weddell Sea, Knox Coast, and Cape Adare areas. Courses to the Antarctic were chosen to help fill existing holidays in soundings and bathythermograph information. Direct current measurements will be made by the geomagnetic-electrokinetograph (GEK) while the ships are under way. It is planned to take oceanographic stations from South Amerira to the Weddell Sea, where additional stations will be attempted across the Antarctic Convergence in both directions. In the Ross Sea area, 33 stations have been located at approximately 50-mile intervals. Off Knox Coast, 8 stations have been specified, but these may be changed and others taken, if possible, across the Antarctic Convergence in both directions. Ships are urged to traverse areas where soundings are sparse while in the Antarctic area. Also, oceanographic work is to be conducted while ships are moored to the ice, when Ekman or Price-Gurley current meters can used to measure currents.

Most of the oceanographic work on the previous Antarctic expeditions was conducted from aboard Navy and Coast Guard icebreakers, including the *U.S.S. Edisto, U.S.S. Glacier, U.S. S. Atka, U.S.S. Staten Island, U.S.C. G.S. Westwind*, and *U.S.C.G.S. Northwind*. The observations taken included temperature and salinity of sea water, dissolved oxygen, bathythermographs (BTs), bottom samples and cores, bottom photography, plankton hauls, fish collection, bottom dredges, currents, water color and transparency, sea and swell and associated meteorology, deep scattering layer (DSL), soundings in near-



AERIAL PHOTOGRAPH *of the first Texas Tower to go into operation.*

shore areas by small boat, sample collection for tritium analysis, and ice observations from ship and helicopter.

Ocean Station Vessels

In furtherance of the oceanographic objectives of IGY, the Office of Naval Research requested the Hydrographic Office to coordinate a program of observation aboard Ocean Station Vessels in cooperation with the Coast Guard. Although plans have not been worked out as yet, it is contemplated that hydrographic winches, oceanographic equipment, and bathythermograph instruments will be supplied these vessels in order that complete Nansen stations and frequent bathythermographs can be taken in addition to the usual wave observations (visual and mechanical), current measurements, and weather observations.

Radar Picket Vessels (YAGRS)

Another program still in the planning stage is one to take oceanographic observations from radar picket vessels (YAGRS) located off the east coast of the United States. At the request of the Fish and Wildlife Service, arrangements are being made to take current measurements, BT observations, surface water samples, and plankton samples.

Texas Towers

Ever since the establishment of the first Texas Tower early in 1956, the Hydrographic Office has taken maximum advantage of this observa-

tional platform in order to collect oceanographic environmental data for the use of various Government agencies. The tower is located on Georges Bank in about 56 feet of water, 110 miles from the U.S. mainland. The platform is triangular in shape, 185 feet on a side, and is about 61 feet above the surface of the ocean.

The first tower of the system is to be a pilot installation for testing and evaluation of various instruments. It is planned that these instruments be completely automatic recorders so as to require a minimum of maintenance. They are to be provided by the Hydrographic Office and other participating Government agencies. Because of limited funds and nonavailability of many instruments, it has been necessary to use some equipment temporarily, even though its performance may not be completely reliable. Present plans provide for the following recording systems:

Wave heights—Two standard Hydrographic Office step-gauge wave staffs will be used; one modified for measuring waves up to 37 feet with step intervals of 1 foot each and the other for waves 12 feet high with step intervals of 4 inches. Recording will be done on Easterline-Angus tapes for later analysis on a wave analyzer.

Underwater pressure—Two pressure recorders will be used, one pick-up being placed on the bottom and the other at mid-depth. They are being adapted for recording on magnetic tape.

Sea and air temperature—Sea temperatures will be recorded at six levels beneath the surface, and air temperatures at five levels above the surface. Thermal elements are copper-constantan thermocouples, and recording will be made continuously

TAKING A HAND SOUNDING *at the tidal crack, head of Kainan Bay.*

on a 20-channel Brown potentiometer.

Solar radiation—Upright and inverted Eppley pyrheliometers will measure incident and reflected short wave radiation. Upright and inverted Gier and Dunkel type radiometers will measure the longer wave radiation. These data will be recorded continuously on the Brown potentiometer with temperature.

Currents—Three Roberts type current meters will be suspended at various levels below the surface to record currents periodically. It is intended eventually to record currents at three levels simultaneously.

Winds—Three continuously recording anemometers have been requested. It is intended to measure speed and direction at close intervals to the sea surface. Inquiries are being made into the use of hot-wire anemometers and other instruments more suitable for low velocity measurements.

Tides—A suitable instrument has been devised for measuring tides from the tower.

Wave forces—Instrumentation for the measurement of wave forces against the tower supports is under investigation by the Bureau of Yards and Docks.

Ambient noise—It is contemplated that an ambient noise measuring system with three hydrophones be installed. While this system is not automatic, it may be possible to modify it for minimum monitoring.

Wave direction—A system for determining wave directions by use of triangulated pressure pickups on the bottom has been proposed by the Naval Research Laboratory.

Bottom seismology—The Lamont Geophysical Laboratory, under contract with the Bureau of Ships, has proposed the use of their bottom seismograph to be positioned at some distance from the tower to record shift noises, earthquakes, explosions, microseisms, and motion of the bottom caused by gravity waves. This instrument records continuously and requires no monitoring.

Atmospheric pressure rate of change—The Lamont Geophysical Laboratory has proposed the use of a rate of pressure change recorder on the tower. This instrument records continuously and requires no monitoring.

Electrical conductivity of sea water—The use of a continuously recording conductivity meter is under consideration.

Operation recording system—A system for recording operation of all data collecting systems is under investigation. Such a device would record the on and off periods of all recorders, thus maintaining a continuous record of all data being taken. Such a system would minimize manpower expediture, reduce errors involved in log keeping, and serve as a permanent reference of data available at any time. The use of manually operated equipment is planned where automatic equipment is not yet available.

Dewline

Oceanographic observations in the Arctic are usually conducted in cooperation with the Military Sea Trans-

TAKING OCEANOGRAPHIC OBSERVATIONS *under less than favorable conditions. Note floating sea ice in the background.*

port Service, since the prime mission of MSTS is to resupply Arctic weather and radar stations. The Hydrographic Office has had an ice forecasting program in operation for several years in order to help guide these ships in and out of the Arctic with a maximum of efficiency and a minimum of damage by ice. The development of adequate forecasting procedures has required the accumulation of large quantities of observational data that are especially difficult to obtain in Arctic areas. Therefore, arrangements have had to be made to collect data from all sources and by all means possible.

Observations on the ships are made on a not-to-interfere basis mostly while ships are at anchor, although

MAKING A BORING *in the Arctic ice pack.*

some (BT) are made underway. Efforts are made to make current measurements at the surface, at 5 meters, at mid-depth, and at 5 meters above the bottom by means of Ekman current meters. In addition, observations of color and transparency and bottom samples are taken wherever feasible. While the ships are in the ice, detailed observations are made, both from shipboard and by helicopter, of the physical appearance of the ice, its movement, thickness, per cent coverage, and other general features. The position of the ice edge is plotted wherever observed.

Long range ice reconnaissance in support of Arctic shipping activity is conducted by U. S. Navy patrol squadrons assigned to Task Force commands, as well as by Royal Canadian Air Force planes. As the ice season progresses, the Hydrographic Office suggests modifications in observational activity in order to meet specific needs of shipping and ice forecasting.

Short range reconnaissance is accomplished by icebreaker-based helicopters as required by icebreaker commanders, as well as by ship observations and shore station observations.

Harbors and Approaches

The Navy is continually making surveys of U. S. harbors and approaches in order to improve our knowledge of the marine environment of home waters. The entire gamut of oceanographic observations is usually run, including tidal data, soundings, temperature and salinity, bottom sediments, marine plants and animals, sea and swell, ambient noise, and currents.

Possible Uses of Data

From the above cursory description, it must be evident that the Hydrographic Office is ever alert to every opportunity for collecting physical oceanographic data, whether it be from ship, airplane, or shore station. Also, contact is maintained with scientific agencies throughout the world engaged in oceanographic and geophysical research, both government and private, in order that data collected by them can be obtained for our files.

Although the Hydrographic Office, in fulfilling its mission in the promotion of the national defense, must amass huge quantities of physical data

in the application of oceanography to military and naval operations, it is hoped that eventually these data can be used in making contributions in such civilian fields as extraction of materials from the sea, harnessing of tidal power, prevention of erosion of our coastlines and inroads of the sea upon the land, elimination of damage to ships and underwater structures done by marine boring and attaching organisms, and many others.

The Flying Fish Riddle

DO FLYING FISHES always turn to the right? This question is posed by an interesting communication from I.O.F. member, Commander Mason D. Schoolfield, U.S.N.R., Retd. He describes the strange behavior of flying fishes in the Pacific Ocean, seen by him while flying patrol bombers during World War II.

Flying at a height of between 700 and 800 feet, at about 135 knots, he was in a most favorable position to study the flights of flying fishes in an area roughly covering Wake Island, Midway and Hawaii. As seen from above, the fish would complete a flight of about 250 feet, drop into the water, and then in about 75 per cent of the cases, almost immediately reappear for a second, shorter flight. But the path of the second flight was nearly always at an angle of 70° to the right of the first flight!

The flights were always straight and the sharp turn to the right was made during a swim of less than 25 feet in length under water. What is the significance of this? Unfortunately no observations were made on the compass direction of flight, nor its relation to wind, wave and swell. The turn might well be an evasive action to escape enemy fish, but why always to the right? Do flying fishes turn to the left in the southern hemisphere? What are the directions of flights and turns relative to wind and swell? Aviators and yachtsmen are invited to watch flying fishes when the opportunity occurs and to send their observations to the Editor.

The International Game Fish Conference

By ERL ROMAN

HARDLY A DAY passes at an institute of marine research that doesn't bring with it numerous questions concerning the seas and their contents. Mainly these questions relate to the game fishes, due to the fact that there are so many salt water sports fishermen who seek, with rod and reel, to do battle with the doughty denizens of the deep.

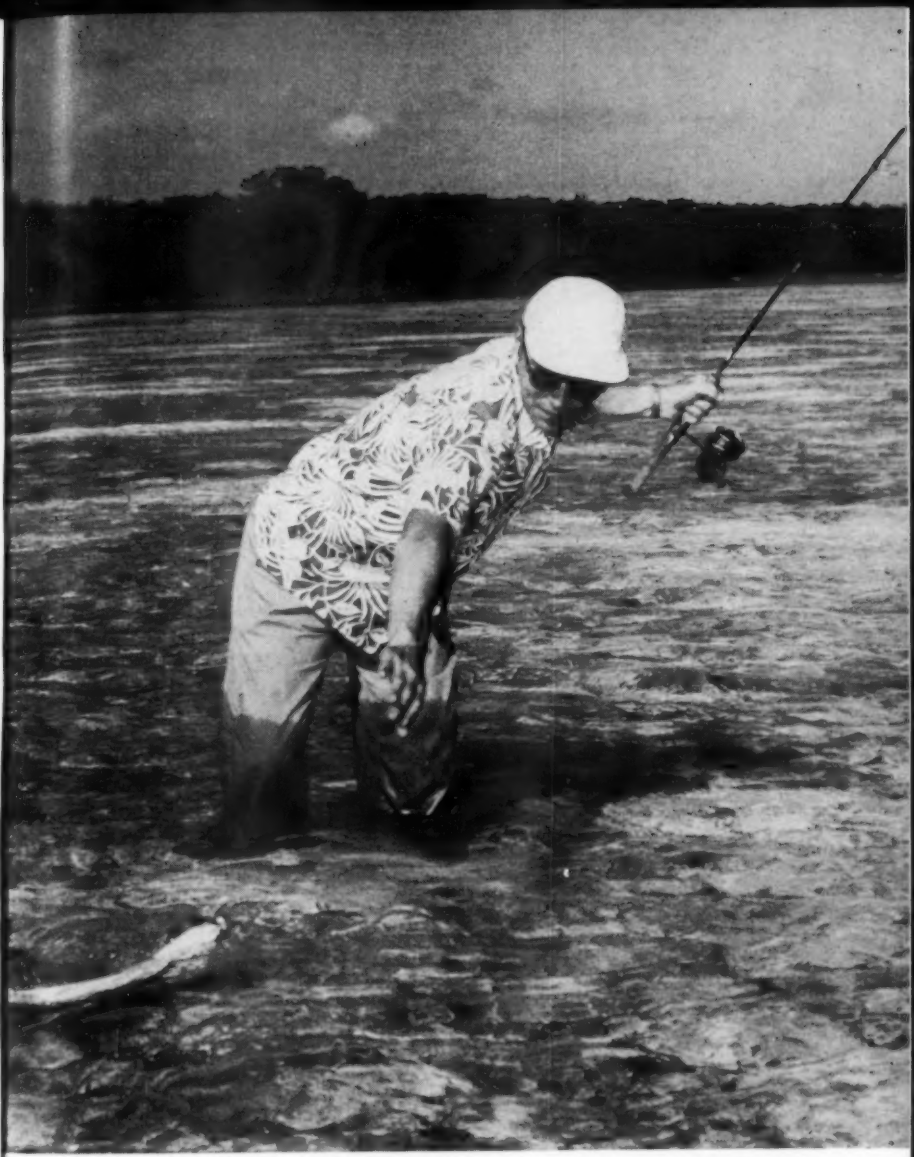
Tough Fishing

Fishing for big gamesters such as the marlins, swordfish and bluefin tuna is an expensive and sometimes unrewarding business. True, bluefin tuna run certain waters at certain times of the year and it is possible to catch many of them provided the angler has the right kind of boat, fishing guide, tackle, bait, and the strength and fortitude required. However, the marlins and swordfish are a different proposition. Long days may be spent without even seeing one of these great fish, and even when they are seen they may not strike the bait. Even if they strike the bait they may not be hooked, and even if they are hooked there is no assurance that they will be boated.

Quite naturally, anglers want to know more about these and other game fish, so they fan out questions in all directions — to their fishing guides, to fishing columnists, to fishing magazines and to marine scientists. Having served as fishing editor with the *Miami Herald* for seventeen years and as salt water fishing editor with *Outdoorsman* magazine for eight years, I used to be stumped for an answer to many of the queries directed my way. When that happened I passed the questions on to the nearest marine scientist of my acquaintance and I felt let down when he could not come up with the answers. Anglers and fishing guides and other fishing columnists with newspapers and magazines throughout the fishing world were doing the same thing and were likewise perplexed when they realized the paucity of knowledge concerning game fishes and sea life generally.

Vast Areas of Sea

There were, and still are, several reasons for the lack of knowledge of the seas and their contents. In the first place, the seas themselves are extensive, covering as they do three-fifths of the earth's surface. Secondly, the contents of these seas offer a bewildering array of materials, both known and unknown. They are, in actual fact, the last frontier to be studied and exploited. They offer a challenge to all of us who are possessed with the normal amount of curiosity, or who have in us the desire



AN APPROPRIATE SPOT FOR A GAME FISH CONFERENCE. *Roy Ovington lands a bonefish at Walker's Cay. The Bahamas, with their miles of shallow sea, offering fine grounds and refuge for countless crustaceans and mollusks, provide ideal conditions for the bonefish* Albula vulpes. *This small game fish is found in great numbers on tidal flats and swash lands throughout the Bahamas. It can be taken on natural baits and artificial lures and can be fished for from skiffs, the shore line or by wading the banks where it is known to feed. The Bahamas score on the world records charts is three records and two ties out of eight.*

WELL-KNOWN ANGLERS *meet in Nassau to discuss scientific side of game fish. Mr. John Manning, on left, discusses his expedition to Chile with Count Warner Mörner, of Stockholm, Sweden.*

to know the unknown and thus add to the world's knowledge.

Mike Lerner, one of the greatest big game anglers, had that desire when he sponsored and led research expeditions for the American Museum of Natural History to the Bahamas, Nova Scotia, the South Pacific, New Zealand, Australia and South America. From these expeditions came a large amount of learning, giving marine scientists an opportunity to see and examine game fishes and other ocean life at first hand.

Outstanding Angler

Later, in 1948, Wendell W. Anderson, Sr., of Detroit, another sports fisherman of prominence, led an expedition to New Zealand for Yale University's Bingham Oceanographic Laboratory and the Peabody Museum. He followed this one with an expedition to Ecuador and Peru in 1953. Then Tommy Shevlin sponsored an expedition in the seas off East Africa for striped marlin and sailfish, the same Shevlin who, for many years, held the world record for blue marlin and was noted for his big game fishing exploits in the Cat Cay-Bimini area of the Bahamas.

The Western North Atlantic Bluefin Tuna Cooperative Research Program, launched by the Marine Laboratory of the University of Miami on January 1, 1952, was and still is sponsored by Charles F. Johnson of Palm Beach, internationally-known big game fisherman and president of the International Oceanographic Foundation. A tremendous amount of information has resulted from this fine program and the work and study continue.

Billfish Research

Billfish research and study of the big-eye tuna has received a wonderful boost through the sponsorship of an expedition led by Lou Marron of New York, another internationally-known big game fisherman. This work was begun by the Miami Marine Laboratory in April, 1954, and has since continued. Mr. and Mrs. John Manning, both noted big game anglers, accompanied Mr. and Mrs. Marron the first year of the research program in the seas off Chile, Peru and Ecuador. They have since continued working on a special assignment in Chile and Peru as field associates of the Marine Laboratory in cooperation with the University of Chile.

Tarpon

Another fine research was underwritten by Roger Firestone of Fort Lauderdale, a member of the International Oceanographic Foundation. This research is on tarpon, the agile gamester that is credited with inaugurating the sport of big game angling and which was at one time deemed impossible to take on rod and reel. The first one to be thus taken was caught by Samuel Jones of Philadelphia while trolling a spoon lure at Indian River inlet on the east coast of Florida in 1884. This research is being carried out by Miami scientists in cooperation with the Florida State Board of Conservation.

International Meeting

So there was only one thing lacking to aid in the seeking of further knowledge of the seas and their contents and that was planned liaison between marine scientists on the one hand and anglers and fishing guides on the other. That lack now has been accomplished with the International Game Fish Conference, first of its kind ever staged. Sponsored by the International Oceanographic Foundation, the conference took place November 27, simultaneously with the sessions of the ninth annual Gulf and Caribbean Institute at Nassau, Bahamas. This was a natural inasmuch as the Institute is organized by the Marine Laboratory of the University of Miami, which is conducting so many research programs on game fishes, including the marlins, swordfish, sailfish, tuna, tarpon, snook, salt water trout and barracuda.

Exchange of Ideas

About fifty marine scientists, anglers and fishing guides attended this first International Game Fish Conference, coming from many of the world's fine fishing areas, including the Bahamas, Barbadoes, Bermuda, Canada, the Canal Zone, Ceylon, Chile, Sweden, the Virgin Islands and the United States. They were there to learn more about fishes and fishing in various parts of the world and to make plans for better and more complete cooperation and exchange of information. Both matters were accomplished, and the meeting was so successful that it will become an annual affair.

The meeting opened with a short address of welcome by Dr. F. G. Walton Smith, director of the Marine Laboratory. Chairman Johnson, president of the International Oceanographic Foundation, followed, explaining the objectives of the conference. He mentioned many things that anglers and fishing guides could do to aid marine scientific institutions in their quest for facts concerning the sea and, he pointed out, the reverse also was true.

The Virgin Islands

The first talk, on the game fishes of the Virgin Islands, was given by Frank J. Mather of the Woods Hole Oceanographic Institute. Mather brought out many little known piscatorial items concerning the waters around the Virgin Islands. Anglers, he disclosed, had been fishing mainly to the south of the islands and he expressed the opinion that the fishing, especially for the big gamesters, would be better to the north. He pointed out, however, that the seas to the north were apt to be more rough than those to the south.

An illustrated talk on the pectoral girdles of marlins was next on the agenda. Given by James E. Morrow of the Bingham Oceanographic Laboratory, Yale University, it supplied data that was of especial interest to anglers and fishing guides, as well as to other scientists present. Although the marlins have been known for more than 150 years, the identity of the various species of these fishes is still confused and is the cause for considerable argument, not only

ANGLERS AND SCIENTISTS *discuss the Nassau program. Mr. Charles F. Johnson, center, with Mr. Louis Mowbray, director of the Bermuda Aquarium (right), and Dr. F. G. Walton Smith, Miami oceanographer.*

amongst anglers and guides but also amongst scientists.

Secrets of the Black Marlin

Morrow's charts, showing clearly the formation of the bone structure girdling the base of the pectoral fins of several kinds of marlins, pointed definitely to a method whereby these game fishes, much sought after by anglers everywhere, could be easily and correctly identified. The stiff or rigid fin of the black marlin was shown to be a well defined character, based upon bone structure of the girdle. The charts were not complete inasmuch as the scientist did not have access to all of the various kinds of marlins, but it was explained that anglers and guides could be especially helpful in this work by reporting in detail on the marlins they catch.

Why Fish Don't Strike

The talk by Louis Mowbray, director of the Government Aquarium in Bermuda, was packed with facts concerning the waters adjacent to those islands. One of the items he brought out was that the spawning period of most of the pelagic fishes of the area was from mid-June to early August. Another was the statement that from one to two months following the spawning period, many surface feeding schools of tuna and other game fishes will not strike at normal sized lures. This, Mowbray said, was because they are feeding on the young stages of newly hatched fish, plankton, et cetera. At that time, he pointed out, only the smallest of lures will entice them to strike. He recommended the use of quarter-ounce feather jigs, streamer or smaller flies, with nothing larger than a size 2/0 hook.

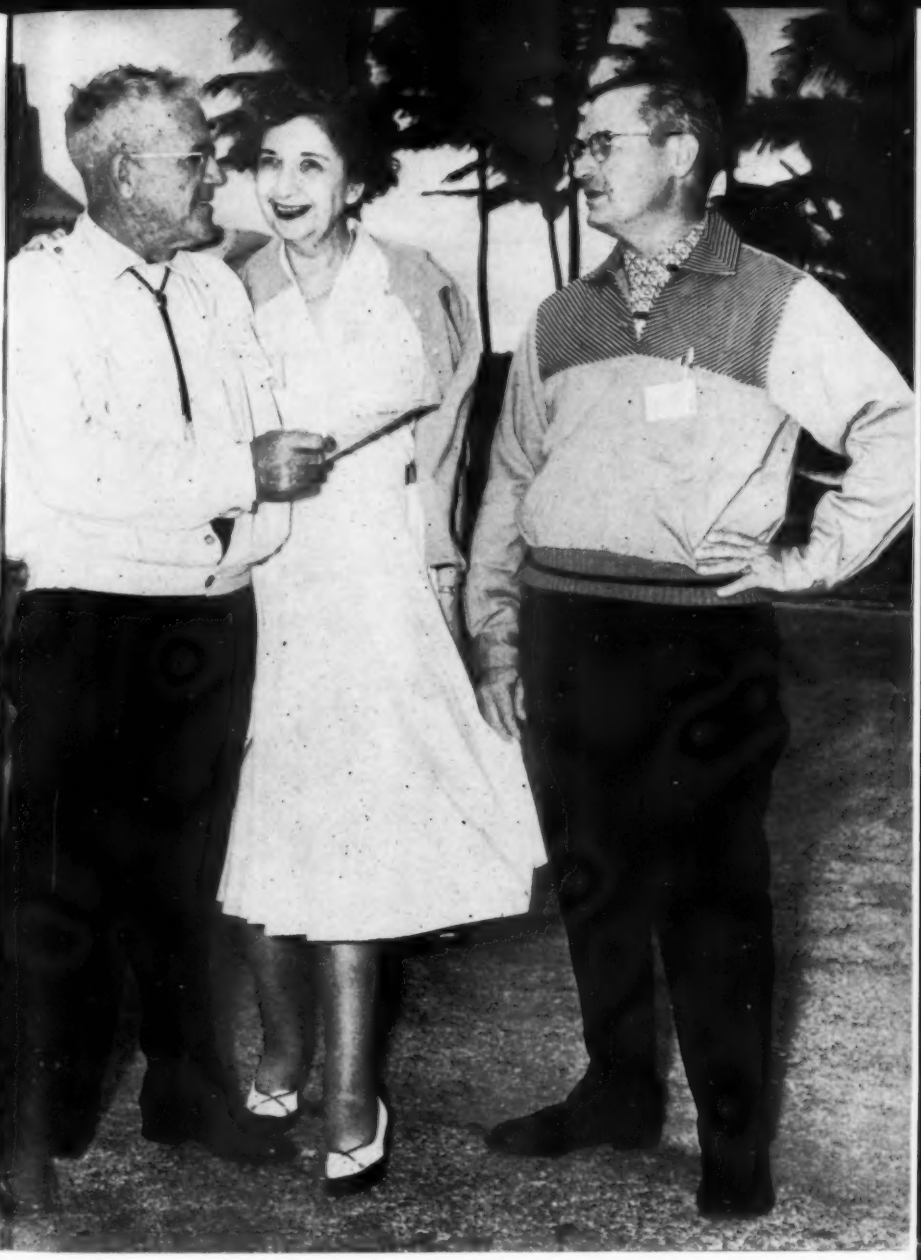
Baby Sailfish

A large amount of information on the early stages of sailfish, swordfish and the marlins and their distribution in the Atlantic Ocean was given by Dr. Gilbert L. Voss, who is in charge of research on the life history of game fishes at Miami. Doctor Voss has spent many years studying billfishes and his knowledge of the subject is tremendous.

John A. Manning gave a complete exposition on the game fishes of Chilean seas. Having been engaged in research in this area during and since his first year with the exposition sponsored by Marron, this former president of the Tuna Club of Catalina knew his subject from its earliest mention in sports fishing to the present time. He not only told of the advance of the area as a big game fisherman's paradise but gave detailed facts and figures on many new offshore fishing grounds that would prove of further interest to visiting anglers.

Cooperation

The afternoon hours of the conference were given over to a discussion of the future aims of game fish research and how the anglers, guides and scientists can best cooperate in such research. Mowbray was named as discussion leader, while the members of the panel were Miss Francesca LaMonte, associate curator of the American Museum of Natural History; Col. John K. Howard, associate



LADY SCIENTIST, *Miss Francesca LaMonte, of the American Museum of Natural History, exchanges ideas on marlins with Frank Violette of Panama (left) and Edward Gorham of Miami.*

GAME FISH IN THE BAHAMAS, *where the international conference took place. Mrs. Stafford Sands lands a wahoo off Big Green Cay, sixty miles south of Nassau. The wahoo is the top winter game fish in the eastern and central Bahamas. It begins to come in from the Atlantic in early November and remains until well into April.*

of the Marine Laboratory of the University of Miami; Morrow, Johnson, Mather and Voss.

Everyone was invited to join in the discussion and many questions were asked and advice sought from the panel and the discussion leader. Many times the situation was reversed and the members of the panel asked questions of the delegates on the floor. Out of it all came certain definite ideas that pinpointed the ways and methods whereby anglers and guides could aid scientists and vice-versa.

Information Exchange

It was, therefore, planned to write and print a pamphlet for the guidance of anglers and others in aiding in the collection and disseminating of knowledge pertaining to the seas and their contents. Among other things, this pamphlet will inform anglers and fishing guides on how to correctly measure the fishes they catch, how to preserve and pack the stomach contents, how to obtain, pack and preserve a section of the gonads and how to send these items to the various marine scientific institutions. The pamphlet will contain especially drawn illustrations to show the angler where the various inner organs of the fishes are located and how to cut into the fish to get these organs or parts of them without injuring the fish for mounting.

This pamphlet will be published by the Marine Laboratory for the International Oceanographic Foundation and will be sent to the Foundation's mailing list of approximately 10,000. Also, it will be sent to other marine scientific institutions to send those on their mailing lists. It will likewise be sent to members of the salt water fishing clubs and to individual anglers on request. This pamphlet should be available within a reasonable time.

Contact the Committee

The Game Fish Research Committee of the Foundation also undertook to correspond with anglers who wish to make collections of specimens or to make observations on their fishing trips. The Committee will put them in touch with research institutions which desire material from the area in question. Scientists or institutions who derive the cooperation of the anglers are invited to inform the committee of the areas in which they would like to secure the help of game fishermen.

Altogether, the conference was remarkably successful. Scientists became acquainted at first hand with the problems and vexations besetting the anglers and guides, while the anglers and guides learned from the scientists of the difficulties and frustrations that confront them. The opportunity afforded by the conference for an exchange of knowledge, ideas and opinions, acted as a cement to join and solidify all those concerned with sports fishing and the sea and if things work out as expected an enormous amount of good will be the result.

Science of the Sea in Books

THE OPEN SEA. ITS NATURAL HISTORY: THE WORLD OF PLANKTON.

ALISTER C. HARDY. Collins, London, 1956, 30/-. Houghton Mifflin Co. Boston, 1957 pp. 1-335. $6.50.

The New Naturalist series has already offered a series of outstanding books. When Professor Hardy set out to write about life in the sea, out beyond the coastal waters, he found that it would take not one, but two books to cover the field. So this first work includes the plankton and some the deep sea fishes, with more fishes, whales, and others still to come.

With his years in the Antarctic on the *Discovery* and later at Oxford, Professor Hardy brings a unique knowledge and enthusiasm to the writing and has produced an outstandingly interesting and readable book. Starting with the sea itself, considered as a living place, and its movements and seasons, he goes on to tell of the various groups of plants and animals which live there. Even to most zoologists this is a revelation of a world of little known forms. It is far more than a description of queer animals though. He tells of the way in which different larval forms have evolved, of the nightly migrations to the surface of swarms of animals which seek the dark depths in the daytime, and of the luminous organs that illuminate them in the deep. He tells also of how plankton studies relate to the fisheries, and how they help in understanding and predicting the migrations of the animals on which such great industries depend.

Professor Hardy's own paintings made with understandable difficulty at sea, contribute much to the work and show, in life colors, what few have had the chance to see for themselves. With these are photographs by Dr. D. P. Wilson, which are of outstanding quality.

This book combines, as few do, a real value to the student of marine science, with a simplicity of language which makes it interesting and stimulating to the general reader. H.B.M.

"MORE JELLYFISH *from our surface waters." Watercolor drawings by Alister Hardy from his book about the world of plankton.*

REALMS OF WATER

P. H. KUENEN. Revised version translated by MAY HOLLANDER. Wiley & Sons, New York; Cleaver-Hume, London, 1955. $6.50.

The universal distribution of water probably accounts for the fact that it is taken so much for granted. If its unique physical and chemical properties were to be changed we should live in a different kind of world, or, more probably, no world of living creatures would be possible. Of recent years, however, the growing demand

upon our water resources has drawn attention to its importance. It is now more generally realized that water is our most important, perhaps our most critical mineral, in relation both to industry and the maintenance of life. The author has attempted to describe the complex and fascinating story of the movements of water from place to place across the earth, as liquid, vapor, and ice and has done so in a manner which makes it intelligible to the non-scientific reader. Nonetheless, this account should be valuable reading for the scientific worker and student.

Professor Kuenen deals with the role of the ocean as the main reservoir of water. From the oceans, by evaporation, water reaches the atmosphere and its further travels are here described as it enters into the formation of glaciers, rain, lakes and rivers and finally journeys back to the ocean.

Possibly for the first time in a book for the general reader the modern views of the origin of sea water and its salts are discussed, but all too briefly from the oceanographer's viewpoint. In addition to explaining why it is now believed that the original ocean may have been dry and the water of the earth may have come from the rocks, rather than from a condensing cloud of atmospheric steam, a brief explanation is given of the probable origin of the salt in sea water.

A chapter on water in the oceans gives a brief account of such questions as the mechanism of tides, ocean currents, wave action, turbidity currents and submarine canyons, and beach erosion.

SEA BIRDS

JAMES FISHER AND R. M. LOCKLEY, Houghton, Mifflin Company, Boston, 1954. $6.00. 9 color photographs and 66 maps and diagrams.

Before my first visit to a famous marine laboratory I was warned to conceal my interest in birds lest I be considered not a serious scientist. Yet sea birds are among the most important of marine animals and it will be a happy day when we know the habits of marine fishes or plankton as well as we do those of the birds. The authors say of this account of the birds of the North Atlantic—"It is intended to exhibit the ignorance of ornithology as much as its knowledge, and to draw attention to what needs doing as much as to what has been done." It is true that any observer at sea may add valuable information to our knowledge of sea birds. This book will tell him much about their courtship and breeding, their food and migration, even the psychological differences between the various kinds. He will need a field guide for identification, but this book will tell him far more of the evolution of the sea birds and the relationship of the varieties found in the different regions of the oceans. This book is the work of two men who probably know the North Atlantic sea birds more intimately than anyone else today and they have produced a well written and most readable book. H.B.M.

THE EARTH WE LIVE ON

RUTH MOORE. Alfred Knopf, New York, 1956. $6.00.

This is a popular account of the structure and history of the earth, its mountains, valleys and ocean basins. It follows the pattern of selecting scientists who have made key contributions to the earth sciences and describing the way in which they developed their ideas. Thus, such historically important men as Guettard, Louis Agassiz, Lyell and Chamberlin dominate the earlier chapters, while Urey, Jeffreys and Kulp, among others, are the cores around which the later ones are developed. This approach should make the book more attractive to the general reader, although the student or scientist may prefer his facts and ideas less diluted

by biographical details. Nevertheless, it is recommended both to layman and professional.

SHIPS OF STEAM

LAMONT BUCHANAN. McGraw Hill, 1956. $5.95.

This is essentially a pictorial history of the development of steamships from the 1780's to the present day. The illustrations are good, many are excellent. Beginning with Robert Fulton's sketches of early steamboat design, it leads up to the Swedish-American liner *Gripsholm,* to enter service in 1957, and the projected Matson, Moore-McCormack and Grace Line additions. On its way it covers historical events and disasters, the loss of the *Titanic* and *Vestris,* the burning of the *Morro Castle* and *Normandie* and the torpedoing of the *Lusitania.* Over 200 illustrations.

THE MIDGET RAIDERS

C. E. T. WARREN AND JAMES BENSON. $4.50. William Sloan Associates, New York. 1954.

Perhaps one of the most interesting developments of the British Royal Navy during World War II was the midget submarine. Certainly it was an unusually effective weapon in relation to its simplicity and economy compared with more conventional naval craft or weapons. Their thrilling attack on the German battleship *Tirpitz,* in the Altenfjord, resulting in her disablement, was a dramatic high spot in their operations. The full scope of the activities of the smaller "chariots" or human torpedoes and one of the larger X-craft or midget submarines has not previously been recorded and, as a result, this type of weapon has been generally regarded as a suicidal device with very limited practical value. Nevertheless, though never utilized on a large scale, the small group of midget raiders accounted for over 100,000 tons of enemy shipping; restricted U-boat repairs in Bergen; freed British capital ships from watching *Tirpitz;* assisted in the invasions of Sicily and Europe and forced the German and Italian navies in the Mediterranean to devote more men and material to harbor defenses as well as destroying two important units of the enemy fleet. These and other operations against the Japanese in the Far East were accomplished with a loss of only 180 officers and men engaged. To those interested in submarine warfare or peacetime underwater devices of possible scientific use, to frogmen and to those interested in ships and the sea, this book will prove a fascinating record of scientific ingenuity and individual bravery.

Worms With Shells

ABOUT 350,000,000 years ago shallow sea bottoms teemed with "shelled worms." Called brachiopods, they were perhaps the most abundant animals on the planet. The dry land probably still was almost devoid of life during this Ordovician period, the second major division of geological time since higher animals first appeared on earth.

These "worms" — actually they constitute a very distinct phylum or major group of animals — have persisted to the present, although they

are now greatly reduced in numbers and species.

The brachiopod has two shells and attaches itself to some object on the sea bottom by a stalk protruding from the larger shell. Through the ages the sea bottom mud, with the shell remains of these animals, was compressed into rock, and in geological upheavals this rock has been elevated into mountains. Shells of the brachiopods thus incorporated into this rock are conspicuous fossils today, and are of considerable value to geologists in dating rock sequences.

In this way, over the past fifteen years at the Smithsonian Institution, literally thousands of brachiopod fossils have been obtained, usually nearly perfectly preserved, from rocks gathered from Labrador to Georgia and westward to Texas, Minnesota and Nevada.

Ripples

New German Trawlers

German trawlers now being built feature the stern trawling plan, whereby nets are drawn up a stern ramp. Some of them are installing Vorth-Schneider propellers placed forward instead of in the conventional stern position. Variable pitch propellers are being increasingly used with diesel engined trawlers, since they allow constant engine speed independent of load and so effect fuel savings.

Whale Shortage

Last year's production of Antarctic whales amounted to 1,796,287 barrels of whale oil and 337,725 of sperm oil, which exceeds the previous year's by over 3 per cent. Nevertheless, scientists of the International Whaling Commission have recommended a reduction from 15,000 to 11,000 units in the quota, in the belief that the fin whale is being overfished. The blue whale has been seriously depleted during the past twenty years. Although it formerly formed 86 per cent of the catch it is now only 6 per cent.

Fishery Exhibition

The second international Fishery Exhibition will be held in Copenhagen this year from September 27 to October 6. The F.A.O. Congress on Fishing Gear will also be held during the autumn, in Hamburg.

New Factory Ship

Two new fish factory trawlers are being built at Renfrew, Scotland, for Chr. Salvesen & Co., of Leith. They will be similar to the 2,500 ton *Fairtry*, which has now been in operation for two years. (See Floating Fish Factories, Page 83, Volume 2, No. 2 of this Bulletin). Apparently this type of modern operation is proving successful.

About The Authors

DON H. BATES, JR.

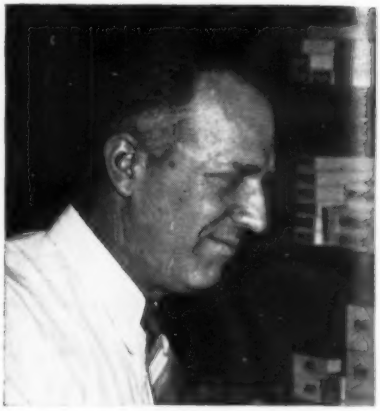
Mr. Bates graduated from the California Institute of Technology with a Bachelor of Science degree and later from the Stanford Graduate School of Business with an M.B.A.

With interest in commercial fisheries, he then proceeded to obtain as much production experience as possible in west coast areas. From cannery work in Oregon, he sailed on a tuna freezership to Central American waters, followed by a summer season with an Alaskan operation. In 1949, he joined the Pacific Oceanic Fisheries Investigations in Honolulu as part of the exploratory fishing and gear development section.

Once again a civilian, he entered Canada as an exchange student and worked six months in several operations with the B. C. Packers Imperial cannery, largest in the British Empire.

Following this, he was employed by a San Francisco firm and transferred to their Peruvian operations where, from a small village north of Cabo Blanco, he introduced longlining for the first time to the Humboldt waters.

Returning to the United States he was temporarily assigned to the red shrimp exploratory program off Jacksonville, Florida, by the Fish and Wildlife Service. He is now employed by a commercial research corporation.



ERL ROMAN

Mr. Erl Roman was fishing editor of the *Miami Herald* for seventeen years and salt water fishing editor of *Outdoorsman* Magazine for eight years. He is author of "Fishing for Fun in Salty Waters" and co-author of "Fisherman's Encyclopaedia" (Gabrielson and LaMonte), and has been writing articles and stories on the sport of fishing for the past forty years.

He is a member of the Board of Trustees of the International Oceanographic Foundation and secretary of the Foundation's Game Fish Research Committee; Eastern Associate and Chairman of the Tackle Committee, International Game Fish Association; chairman of the Cat Cay International Bluefin Tuna Tournament Committee; member of the Board of Directors of the Metropolitan Miami Fishing Tournament, Inc., and member of the tournament committee. Mr. Roman has received both State and National awards for his work in the conservation of natural resources. For the past eleven years he has been associated with the University of Miami.

Progress

IN THE SHORT PERIOD of its life, the Bulletin has now reached a circulation of 10,000, not all of whom are members. They are drawn from the United States, Canada, Central and South America, Great Britain, Australia, France, Germany, Italy, Denmark, Sweden and Norway, as well as a few from the Pacific Islands and the West Indies. Continued improvement will be possible with growth of active membership. It will be seen in better service, with more articles in the Bulletin of high interest and authenticity and, eventually, a monthly issue in full color.

Members are joined in these aims and they are urged to make progress possible by taking the small effort needed to enlist new members. To those who are not members, but whose interest and curiosity lie in the sea and the spirit of discovery, there is extended an invitation to participate by simply mailing a card. The ocean is our last frontier and its exploration still under way.

The editor will be glad to consider for publication articles and illustrations covering explorations, discoveries or advances in our knowledge of the marine sciences or describing the activities of oceanographic laboratories or expeditions in any part of the world.

ACKNOWLEDGMENTS

THE FRONT COVER illustration of a mullet fishing net, and Pages 4, 7, 23, 25, 27, 28, 30, The Marine Laboratory, University of Miami. THE BACK COVER by Charles E. Lane.
Page 2, Shell Oil Company; Pages 3, 32, 34, 35, Robert W. Ellis; Page 8, International Nickel Company, Inc.; Pages 9, 10, 11, 12, 13, Harvey Bullis, U. S. Fish & Wildlife Service; Pages 14, 16, 17, 18, 19, Philip & Son, Ltd., Dartmouth, England; Page 23, Charles Davis; Page 36, U. S. Coast Guard; Pages 38, 40, 42, 43, 45, 46, U. S. Navy Hydrographic Office; Pages 49, 50, 53, 55, 56, The Development Board, Nassau, Bahamas.

Contents of Volume 2

PAGE

NUMBER 1

Many Explorations ..... F. G. Walton Smith 3
Deep Sea with the *Albatross* 9
Mosquito Fleet ..... Francis B. Taylor 17
Gold Coast or Sailfish Frontier 21
Science of the Sea in Books 30
Marine Monsters ..... F. G. Walton Smith 32
The Food of Tunas ..... Donald de Sylva 37
The Fisherman Fished ..... Charles E. Lane 49
Are New Shrimp Boats Acomin'? ..... Edwin H. Mairs 54

NUMBER 2

More to Fishing than Fish ..... F. G. Walton Smith 67
Saltwater Game Fish 73
Floating Fish Factories ..... Robert W. Ellis 83
Rivers in the Sea 89
Treaders of the Sea ..... J. L. McHugh and H. B. Moore 105
The Amazing Angel Shark ..... Bernard L. Gordon 109
Science of the Sea in Books 111
Ups and Downs ..... Hilary B. Moore 113
Game Fish Reports 116
New West African Fishery 117
Oceanography Recruits a Dane 119

NUMBER 3

A Report to Members ..... F. G. Walton Smith 131
Fingerprinting Fish ..... Alfred V. Volpe 135
UNESCO and the Marine Sciences ..... Masao Yoshida 143
Monsters of the Ancient Seas ..... F. G. Walton Smith 152
Darwin Anniversary 164
Queer Fish 165
Biological Oceanography in British Columbia
..... Robert F. Scagel 166
Science of the Sea in Books 173
Turtle Headed Seal 181
Nassau Game Fish Conference 182
Ocean Birds ..... Hilary B. Moore 185

The International Oceanographic Foundation

"To encourage the extension of human knowledge by scientific study and exploration of the oceans in all their aspects, including the study of game fishes, food fishes, ocean currents, the geology, chemistry, and physics of the sea and the sea floor."

President	MR. CHARLES F. JOHNSON
Vice President and Secretary	DR. F. G. WALTON SMITH
Vice President	MR. R. HARDY MATHESON
Treasurer	MR. JOHN MAHONY

BOARD OF TRUSTEES

Admiral Leo O. Colbert	Mr. John A. Manning
Mr. George Collier	Mr. R. Hardy Matheson
Mr. Allison Fleitas	Dr. Raymundo De Castro Maya
Dr. Paul S. Galtsoff	Mr. Al Pflueger
Mr. Ernest Hemingway	Mr. Erl Roman
Colonel John K. Howard	Dr. Waldo Schmitt
Mr. Charles F. Johnson	Dr. F. G. Walton Smith
General Robert Wood Johnson	Colonel Frederic A. Wanklyn
Dr. John Oliver LaGorce	Mr. Louis Wasey
Capt. E. John Long	Mr. Erik Wijk
Mr. John Mahony	

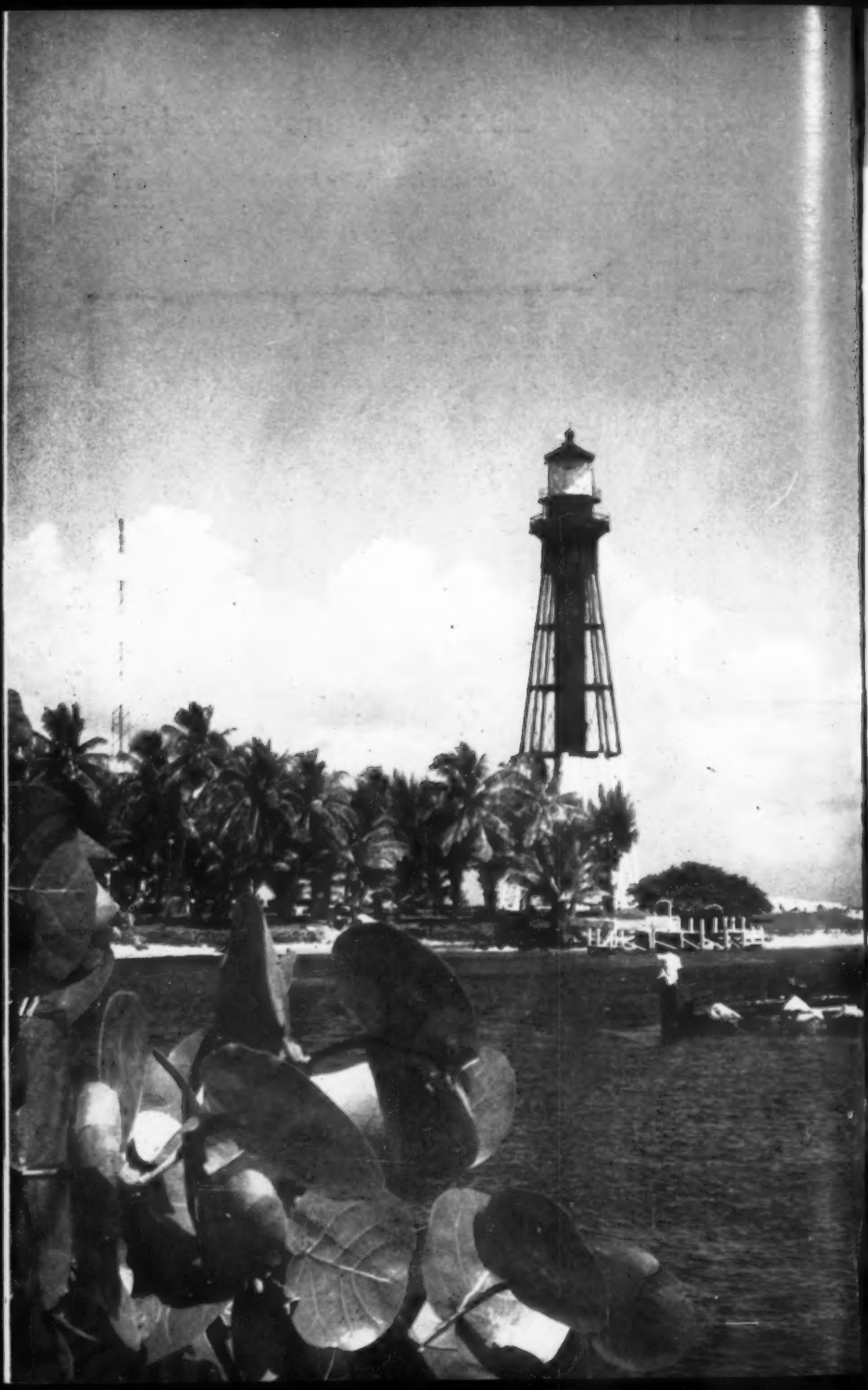
COMMITTEES

Game Fish Research	Grants and Awards
Aquarium	Publications
Membership	Finance

MEMBERSHIP

The Foundation was established by a group of saltwater anglers, yachtsmen, shipowners, marine scientists and others interested in the scientific exploration of our last frontier, the ocean. Its objectives are to provide support and encouragement for marine research, exploration and discovery and to promote the collection and dissemination of scientific knowledge about the ocean.

Qualifications for membership are an interest in the oceans and a desire to extend and develop scientific research and exploration into them. Support given to research through personal activities or donations is recognized by the Foundation through the following classes of membership. Members are those who make annual contributions of $5, Fellows $25 annually; Life Fellows are those who contribute $200 or more or who have otherwise helped to advance the purposes of the Foundation; Sponsors who contribute $1,000 or more; and Patrons who contribute $5,000 or more.

According to a ruling of the U.S. Treasury Department, donations made to the Foundation are deductible in computing taxable income as provided for by the 1954 code.

Offices: The Marine Laboratory, University of Miami,
439 Anastasia Avenue, Coral Gables 34, Florida